Irrigation Assessment Findings and Recommendations

Prepared by Brent Willey, March 2016

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ACRONYMS

AMT	Agriculture Marketing Technician
AIFA	Asia Innovative Farmers project
CEAPRED	Center for Environmental and Agricultural Policy Research, Extension and Development
CEG	Clean Energy Group
DADO	District Agriculture Development Office
DC	District Coordinator
DDC	District Development Committee
DEPROSC	Development Project Service Center
DOA	Department of Agriculture
ECARDS	Environment, Culture, Agriculture, Research, and Development Society
EIG	Education for Income Generation
FGD	Focus Group Discussion
GI	Galvanized Iron
GM	Gram(s)
GON	Government of Nepal
GS	Galvanized steel
Ha	Hectare
HDPE	High Density Polyethylene
HP	Horsepower
HR	Hour
IAPAC	Initiative for Agriculture Productivity and Commercialization
IPM-IL	Integrated Pest Management – Innovation Lab
IT	Irrigation Technician
KG	Kilogram
KISAN	Knowledge-based Integrated Sustainable Agriculture and Nutrition
LPS	Liters Per Second
LSP	Local Service Provider

LIT	Liter
MM	Millimeter
MoU	Memorandum of Understanding
MPC	Marketing and Planning Committee
MS	Mild Steel
MTJ	Modified Thai Jar
MUS	Multiple Use water System
NARC	Nepal Agricultural Research Council
NEAT	Nepal Economic Agriculture and Trade
O&M	Operation and Maintenance
PERSUAP	Pesticide Evaluation Report and Safe Use and Action Plan
PVC	Polyvinyl Chloride
RCC	Rod Cement Concrete
RS	Rupees
RPM	Revolutions Per Minute
RSDC	Rukmeli Social Development Center
SIMI	Smallholder Irrigation Market Initiative
SN	Serial Number
UNDP	United Nations Development Program
UPVC	Unplasticized Polyvinyl Chloride
USG	United States Government
VDC	Village Development Committee
USAID	United States Agency for International Development
VAT	Value Added Tax
VDC	Village Development Committee
WIKISAN	Winrock International Knowledge-based Integrated Sustainable Agriculture and Nutrition

INTRODUCTION

Winrock International, in consortium with local implementing agencies CEAPRED and DEPROSC, is responsible for the five year, $20.4 million, USAID funded KISAN project which is focused on 20 districts of the west, mid-west and far-western parts of Nepal. An agriculture initiative that initially incorporated only nominal support for irrigation schemes has increased focus on agricultural water supplies over the life of the project while also attracting significant match funds. Although data is not complete, to date over 10,770 farming households are benefitting from increased access to irrigation. The cumulative projected budget for irrigation schemes is just under Rs. 30 million (approximately $283,000) while more than Rs. 30 million has already been leveraged for the various facilities.

To gain a better understanding of how the irrigation work is proceeding a consultant was engaged to carry out a field study. A key part of the study entailed holding Focus Group Discussions (FGDs) with 15 KISAN Farmer Groups that had received irrigation support. The groups are located in seven districts covering all three programmatic regions (*refer to Annex I for group details*). The group size, ethnic and gender composition varied as did their capacity to relay their 'narrative.' The FGDs explored the process and impact of irrigation support (e.g. how group was selected, types of trainings they had received from KISAN, how the irrigation support was manifest including support amount and type of facility). The discussion around impact varied according to when the irrigation schemes had gone into effect - as the amount of support has varied significantly between Year 2 and 4 - and only provides a snapshot of the ground reality.

KISAN's irrigation support has helped to enhance the cumulative effect of KISAN inputs (e.g. technical instruction as well as linkages to private sector actors including input suppliers and buyers). FGDs consistently revealed new cropping patterns (types of crops, off season production); increased use of 'new' technologies, such as plastic tunnels and hybrid seed; increased vegetable consumption; and an increased commercial orientation characterized by higher yields and increased earnings. KISAN follows a clear and well established irrigation scheme selection process to minimize conflict over access to water and pump use and provides an orientation to all farmer groups on good practices for the operation and maintenance of irrigation systems. Recommendations include improving access to solar powered irrigation technologies and improving the business and financial literacy of farmers. On this latter, farmers are hesitant to invest in irrigation notwithstanding the significant increase in earnings that can result from a new irrigation system.

While water is an essential farming resource, the irrigation study looked beyond irrigation inputs and examined organization of the farmer groups and group functions/practices, as well as capacity development opportunities to determine how the irrigation support might be affecting them. A questionnaire was used to stimulate discussion and inevitably the FGDs touched upon a variety of topics which were then pursued as part of the discussion. Thus, a number of observations in this report go beyond the strict realm of irrigation with a focus on catalysts for, and challenges to, improved farming practices.

BACKGROUND

The irrigation study was concentrated in two districts of the Far West (Doti, Kailali), four districts of the Midwest (Bardiya, Surkhet, Dang, Salyan), and one district of the West (Kapilvastu). Access to water varies amongst these hill and Terai districts due to a variety of factors including proximity to water sources, water table issues (e.g. Kapilvastu has a lower water table than neighboring Dang), and presence of a functioning relay system, such as a pump and distribution pipe or canal, that can channel water to fields on a regular basis.

KISAN's selection process for groups to receive irrigation support was generally straightforward, relying on recommendation of the Agriculture Marketing Technicians (AMTs), who had been interacting with and providing technical support to the groups in the form of various agriculture trainings. Groups were chosen utilizing selection criteria as detailed in *Table 1 below.* Also, refer to Annex II for a detailed chart illustrating process/steps followed to implement irrigation schemes.

Table 1. Irrigation Scheme Support Selection Criteria

- Technical feasibility of irrigation schemes (appropriate site and technology)
- Farmer Group cost share
- Lack of irrigation facility in the proposed area
- Production and marketing potential area (e.g. road access)
- Concentration of households around new water source (amplifying coverage)
- Low cost of construction
- Farmer Group responsible for Operation and Maintenance fund
- Low degree of conflict/ no objection regarding use of the water source (not one person from the farmer group can object; also VDC border areas avoided)
- Potential of group members to increase production - they should be interested in and working towards commercial production
- Availability of high leveraging resources from district line agencies
- VDC/District level demand (VDC/DDC/DADO)
- Irrigation scheme coverage of at least five to ten households (minimum five households in hill districts and ten in Terai districts).

Irrigation support has changed dramatically since it was first implemented in Year 2 (July 2013 – June 2014) of the project. At the outset, a very limited number of irrigation schemes were supported (48) and the financial amount was modest (Rs. 9,000/farmer group). No contribution was required on the part of the farmer groups. However, leverage was accessed from line agencies in order to make a meaningful contribution. Typically, electric pumps were supported in the Terai, while plastic ponds and HDPE (high density polyethylene) pipes were supported in the hills.

In Year 3 the financial amount was more than doubled (to Rs. 20,000/scheme) and the target numbers also increased significantly: 304 schemes were supported across all 20 program districts - 62% in the hills where they are arguably most needed. The enhanced funding amount was important in that a variety of schemes were implemented according to context and need which proved to be a critical enabler of increased irrigation. Schemes took the form of shallow tube wells (30%), water harvesting tanks with pipes (16%), plastic ponds (10%), electric pumps (7.5%), diesel pumps (3%), canals (9%), drip irrigation

(3%), pipes and sprinkler (1.6%), Multiple Use Systems (MUS, 1.6%), pipe only (16%), and solar lift (3 schemes supported).

In addition, 98 schemes were supported for rehabilitation in Year 3. The per scheme budget was limited to Rs. 3,000 which typically covered distribution pipes in the Terai, and galvanized iron fittings for existing systems in the hills. The vast majority of rehabilitation schemes (89%) were concentrated in the Terai. Leverage for rehabilitation schemes was primarily provided by farmer groups, Village Development Committees (VDCs) and District Agriculture Development Offices (DADOs). Refer to Table 2 below for a year by year summary of irrigation support.

Table 2. Irrigation Facility Details

Implementation Year	Target	Actual No. of Schemes	Total Budget (Rs.)	Leverage Amount (Rs.)	No. Beneficiary Households[1]	Total Area Covered (Ha)
Y2	48	48[2]	144,000	TBD[3]	685	91.8
Y3	393[4]	402[5]	5,794,000	22,087,026	6,956	1,133.66
Y4	500	190[6]	15,989,000[7]	5,865,226	3,129	590
Y5	250[8]	N/A	7,500,000	2,500,000[9]	TBD	TBD
Total [10]	**1,191**	**640**	**29,427,000**	**30,452,252**	**10,770**	**1,815.46**

A total of nearly 7,000 households, or approximately 35,000 people, benefited from the irrigation support in Year 3.[11] In the process, a variety of leverage sources were accessed including from the Government of Nepal (GoN) - Department of Agriculture's Raising Incomes of Small and Medium Farmers Project (ADB), Ministry of Irrigation's Underground Water Resource Development Project (Bhumigat Jhalshrot Bikash Pariyojan), District Agriculture Development Offices (DADO), District Irrigation Offices, VDC/ Municipalities; United States Government (USG) supported programs including PACT (Sajhedari Bikash) and Peace Corps[12]; and other projects including the Poverty Alleviation Fund (through DEPROSC and ECARDS), Initiative for Agriculture Productivity and Commercialization (IAPAC) project, Rukmeli Social Development Center (RSDC), Sahash Nepal, SUDAC Nepal, Mainstreaming

[1] Includes households that are both farmer group members as well as other neighboring farmers benefiting from the irrigation scheme.
[2] Includes 24 demonstration sites and 24 matching fund schemes.
[3] Data unavailable.
[4] The total is comprised of 275 new irrigation schemes and 118 rehab schemes.
[5] The total is comprised of 304 new irrigation schemes and 98 rehab schemes.
[6] Data as of the end of February 2016; Year 4 ends in September 2016.
[7] Estimated Year 4 irrigation budget takes into account average per scheme cost of Rs. 30,000 for 484 schemes, as well as 14 MUS schemes at the rate of Rs. 100,000/scheme.
[8] Year 5 officially ends in July 2017. Estimated budget is Rs. 30,000/scheme.
[9] This figure represents the minimum community match (Rs. 10,000/scheme) x 250 schemes. The total, however, will very likely exceed this amount.
[10] Totals are incomplete.
[11] Based on average family of five.
[12] Refer to Annex VIII for case studies focused on Sajhedhari collaboration/leverage, engagement with Peace Corps, and a Dang farmer group that is involved in seed production.

Disaster Risk Reduction and Enhancing Response Capability Project (Oxfam/IDeS), Nepal Climate Change Support Program (UNDP), and Winrock International's Clean Energy Group (CEG).

Although it wasn't a program requirement, in order to maximize program investment and impact, a significant number of farmer groups also contributed to the schemes in Year 3. This best practice was converted into a requirement, in the form of mandated 1/3 leverage, for Year 4 so as to promote ownership and sustainability. In Year 4 the irrigation activities budget was also increased with an allotment ranging from Rs. 23,000 to 40,000/scheme depending on nature of the irrigation facility. A total of 500 schemes are targeted including 14 MUS in Year 4. Likewise, 250 schemes are targeted for the final year of the project.

Targets were set based on the number of farmer groups in the district. Banke, Dang and Bardiya have the highest numbers of farmer groups and members (467, 462, and 462 groups respectively) compared to the other Terai districts which have about 40% less beneficiaries, and hill districts which, on average, account for 73% less.[13] MUS targets are relatively low in number for Year 4 (one per 14 of the program hill districts) due to the cost for of providing pipes from water source to storage tank. Each of these schemes will be implemented with leverage from other agencies (mostly GoN) as an average MUS costs at least Rs. 250,000. Besides availability of leverage, other criteria used to prioritize MUS include communities with little access to drinking and productive water; where there may be potential conflict over water rights, the farmer group must obtain a 'source authorization' letter from the VDC.

As of the end of February 2016, 190 schemes had been completed with 46% of the overall targets concentrated in the six Terai program districts (Kapilvastu, Dang, Banke, Bardiya, Kailali, and Kanchanpur) and the remaining 54% focused in the 14 program hill districts.[14] The majority of schemes supported so far have been focused on shallow tube wells (103), followed by water canals (27), storage tanks with pipes (19), lift irrigation in the form of diesel pumps (9) and electric pumps (6), as well as drip irrigation (2) and distribution pipes (24) to hill district farmer groups that already have water tanks. A total of 3,129 households, corresponding with approximately 15,645 individuals, are benefiting from the irrigation resources. Refer to Annex III, for an overview on the different types of irrigation schemes supported by KISAN.

Program records on irrigation support are broken down by type of scheme; number of households covered by the scheme; area covered; leverage amount and leverage sources. There is also documentation of key steps in the irrigation scheme planning and implementation process including farmer group irrigation facility request letter (*see Annex IV for template*), farmer group irrigation scheme agreement with KISAN (*see Annex V for template*), and record of scheme completion (*see Annex VI for template*). What's noticeably missing from irrigation reports, and Winrock's WIKISAN database, are lessons learned/best practices as well as documentation of qualitative and quantitative impacts of irrigation on farmer practices. Granted, irrigation support in Year 2 was limited and thus the impact, in terms of stimulating change, was also minimal. By the end of Year 3, however, as a large number of schemes had come online some trends should have emerged in regards to changing farmer practices, such as increasing off-season vegetable production. Moreover, case studies chronicling key catalysts and indicators of change/movement towards commercial production (e.g. increased use of inputs and

[13] Farmer group members in Banke, Bardiya and Dang collectively represent 35% of KISAN's farmer group population. By contrast each of the far western program hill districts comprise about 2% of the total farmer group beneficiary population.
[14] Palpa, Arghakhanchi, Gulmi, Pyuthan, Rolpa, Rukum, Salyan, Surkhet, Dailekh, Jajarkot, Achham, Doti, Dadeldhura, Baitadi.

modified cropping patterns) would be useful in highlighting impact of irrigation support, including challenges and how they were overcome.

Along with irrigation support, farmer groups also received Operation & Maintenance (O&M) training (*refer to Irrigation Operation & Maintenance functions in Findings section on page 17 for more details).* The overall focus of the training was to promote sustainability and included content on conflict mitigation and equity of water sharing (e.g. rotating delivery pipes on a regular basis), as well as basic operation and maintenance according to type of scheme along with fundraising to cover maintenance. Refer to *Table 3 below for O&M training details as well as Annex VII for detailed irrigation training guidelines.*

Table 3. Irrigation Scheme Operation and Maintenance Training Details

Program Year	No. Trainings	Female Participants	Male Participants	Total Participants
Y2	46	-	-	656[15]
Y3	381	4,425	2,928	7,353
Y4[16]	126	1,590	794	2,384
Y5	N/A	N/A	N/A	N/A
Total[17]	**553**	**6,015**	**3,722**	**10,393**

SUCCESS STORY

A particularly impressive irrigation scheme utilizing renewable energy was visited in Taule/Chinchhu, Surkhet. Sita Ram Farmer Group here was able to leverage support from both KISAN and Winrock CEG, as well as Chinchhu Municipality, and along with their own Rs. 300,000 investment (in the form of a loan), secured a nine panel solar irrigation system (*see photo below*) which is proving to be a game changer for the group members, some of whom are now enjoying dramatically increased yields. Bhim Bahadur Gurung, 42 (husband of a group member and pictured in their field below right), is a prime example of growing commercial success. Before the irrigation system arrived they planted corn which

[15] Y2 data is estimated at a little over 14 people/training as extrapolated from the total beneficiary number for 48 schemes; this data is not disaggregated by gender.
[16] Year 4 data represents updates through February 2016.
[17] Total figures are only through February 2016.

was dependent on rainfall. In a good season they were able to grow 400 kilograms of corn and sometimes only half that amount, but no commercial vegetable (only a bit for home consumption). Since receiving support from KISAN, and benefiting from the new solar pump system, their yields have grown exponentially. For example, they've grown 3,200 kilograms of tomatoes which sold at an average market rate of Rs. 40/kg; as well as 1,500 kilograms of chili pepper which commanded an average of Rs. 45/kg. From these two off-season vegetable crops alone they earned nearly Rs. 200,000, minus about 12% of this figure for inputs.

They've planted bitter gourd, cauliflower, cucumber, onion and more chilies this season and Bhim Bahadur estimates that they'll earn an additional Rs. 150,000. Moreover, they no longer have to purchase vegetables for their family and he estimates that they save Rs. 10,000/year. Two years ago his local prospects weren't as bright and he migrated to Qatar for work but returned home disappointed only six months later as the job wasn't good. 'Now I don't need to go', he commented. Currently he and his wife are completely engaged in farming and raising poultry. According to his brother, Dev Gurung (whose wife is also a group member), "Off season is where the benefit is, there's no use trying to grow crops for sale during the main season".

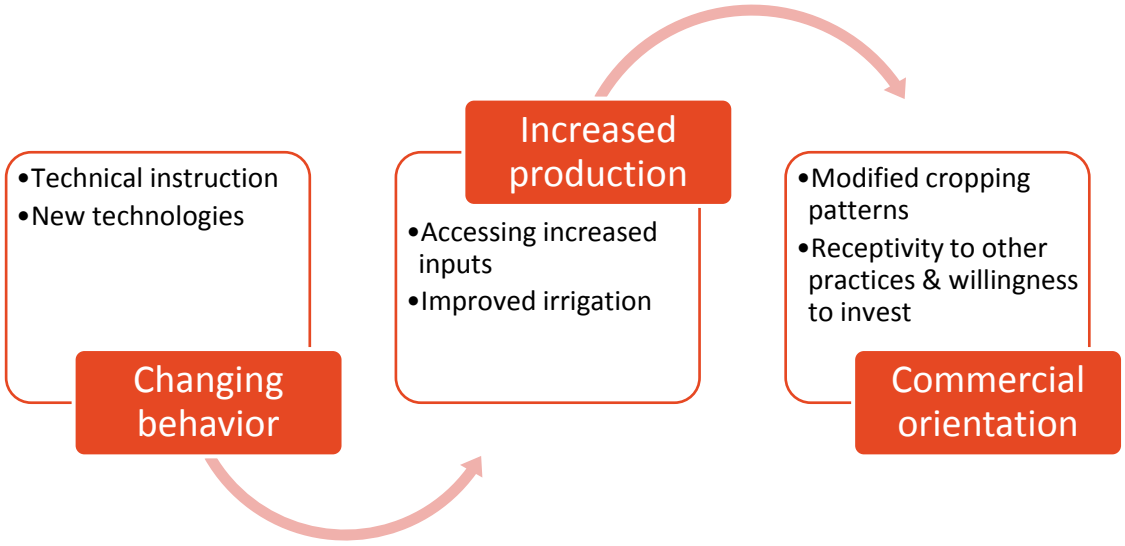
One of the primary lessons learned is that this group, or at least some of its members, enjoyed some existing advantages and connections which, along with their energy and willingness to try new things, is now reaping benefits (including a Youth Self-Employment prize worth Rs. 40,000 awarded by Surkhet DADO to Bhim Bahadur; the nomination was done by KISAN). In terms of replication, it's clear that irrigation alone is not responsible for the progress seen in Taule. It is, however, a critical input which, along with other cumulative inputs has led to a more productive setting.

The group was also willing to invest their own money, through a loan which they accessed through a co-op (*see signboard at right which details the solar scheme financing breakdown*). But they also seem like they were a bit better off to begin with (e.g. their ability to construct a cement reservoir with their own funds). Their first KISAN supported training was held two years ago so they had exposure and realized that lack of water was going to be a serious hindrance to increased production. Through Dev Gurung, who works as a contractor and travels frequently, contact was established with Winrock International's Clean Energy Group (CEG), and KISAN's Agriculture Marketing Technician (AMT) then liaised with CEG to move the plan along. The dynamics of farmer groups are clearly influenced by family members input and connections and, in this case, proved to be an essential catalyst in arranging for the solar powered pump.

FINDINGS

a). Cumulative effect of KISAN inputs: All 15 farmer groups received a number of KISAN trainings, and in some cases trainings/support from other projects, such as IPM-IL, and DADO. This is an important consideration as impact of increased irrigation could well have been muted in the absence of technical trainings and follow-up support. In other words, impact can be attributed to cumulative program influences in the form of technical instruction, new materials and inputs, and of course irrigation. In addition, other linkages, such as establishment of Marketing and Planning Committees (MPCs) and introductions to private sector actors - such as vegetable brokers or foundation seed suppliers, as well as capacity development of agrovets to supply new products and deliver improved information and instructions to farmers - collectively influence farmer decisions.

These compounded inputs create momentum, and as communities adopt new practices and see each other applying new techniques, using new materials and equipment, and adopting new technologies there is a ripple effect that stimulates further behavior change and replication. Moreover, farmers are prompted to question practices. This development of critical skills is important as they collect advice, analyze their new approaches and further upgrade their agriculture practices (*see schematic below which outlines the KISAN processes and inputs involved in prompting behavior change*).



b). Irrigation as catalyst and motivator: a number of farmer groups mentioned that the KISAN support had served as a process accelerator even if the monetary support was modest. For example, Bardka Farmer Group in Sathbariya Dang involved in seed production only received limited support from KISAN. The bulk of support for their water system was accessed through other sources including a Community Forest Users Group. However, key linkages were made by KISAN, such as to a foundation seed supplier in Chitwan, and along with technical trainings, the financial support served as a motivator and enabled further community leveraging for their water system. Farmer Group members appear responsive to the irrigation support leverage requirement as they see accountability with the irrigation scheme as KISAN staff are visible and providing technical support, records are maintained, and systematic processes are

encouraged for the sustainable use of the irrigation system (e.g. Operation and Maintenance Fund; *for more details, see case study #3 in Annex VIII*).

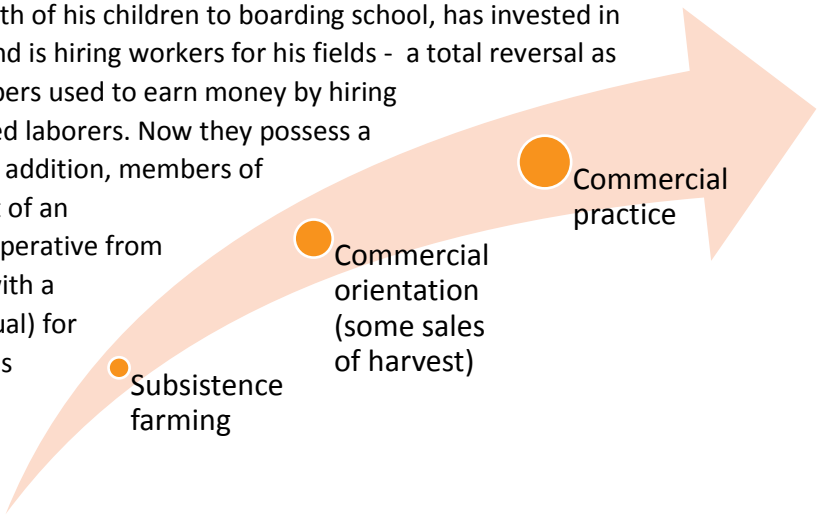
c). Dependence on subsidies: even where individuals or groups might be able to afford irrigation equipment, such as a pump, they will often hold out for a subsidy. This has created a distinctly unfriendly market environment while farmers are also inhibiting their own progress. This dependency mindset represents a huge barrier to behavior change and taking initiative to try new agricultural practices. Ironically, a number of farmer groups mentioned that modest KISAN support had leveraged much more substantial support for irrigation projects, such as canals, that could not be accomplished with KISAN funding alone. Fortunately, there does appear to be a tipping point in which farmers have benefited from, and exhausted other, subsidy opportunities to a sufficient degree that they go on to purchase materials on their own to further expand their agriculture operations. An emerging good practice to support this trend: KISAN previously provided plastic tunnel demos free of cost while current practice entails farmers paying for the plastic, and procuring the other locally available materials such as bamboo, while KISAN covers the technical support cost to increase ownership. The degree of follow-up technical assistance provided outside of trainings seems to depend on the AMTs relationship with the groups.

d). Commercial orientation vs. commercial farming: there is a trajectory that successful farmers follow in earning an income from agriculture, and not just relying on their fields to feed their family and generate a little spending money. This entails a shift from subsistence orientation to a commercial orientation, to outright commercial level farming. This scenario was repeatedly encountered across KISAN districts: farmers who, only a few years ago, were stuck in a holding pattern unable to generate substantial earnings from their fields, and reliant on other work to generate cash, are now earning money from their crops.

Ram Chandra Tharu, of Milan Farmer Group in Kalika, Bardiya is a prime example (*see photos below*). Currently he is operating 25 plastic tunnels while six years ago he didn't patronize agrovets, and relied on local seed as the only input. Not surprisingly his production is exploding: he harvested 2,500 kilograms of cucumber, 900 kilograms of bottle gourd, 800 kilograms of cauliflower, and 700 kilograms of cabbage this winter and is earning 'not less than Rs. 250,000' over the last year. This cash growth from vegetable production is a recent phenomenon as Ram Chandra and his fellow farmer group members started making money from vegetables only 1 ½ years back with yields significantly increasing once the irrigation support kicked in one year ago and resulting in double yields for his cauliflower and three-fold yield increases for his cucumber crop.

This movement towards commercial practice didn't occur over night. Milan Farmer Group was originally established under, and received training/technical backstopping from, Winrock's Education for Income Generation (EIG) project. At that time, the group members planted vegetables only for home consumption. Subsequent trainings and other support was provided to the group by the USAID funded SIMI, NEAT and KISAN projects. Thus, the farmers have moved along a knowledge and experience continuum, adopting new practices and technologies along the way as they have become comfortable with the processes and investment costs. Ram Chandra is clearly turning the corner from commercial orientation to commercial practice.

Not surprisingly, as Ram Chandra gains experience with vegetable production he is also seeing ways of applying his new practices to grain production which is resulting in increasing yields. While grains are not as profitable as, say, off-season vegetable he is at least able to generate profit through different production cycles/seasonal calendars. Social changes are also afoot for his family as represented by the fact that he now sends both of his children to boarding school, has invested in his brother's cyber café and is hiring workers for his fields - a total reversal as he and other group members used to earn money by hiring themselves out as unskilled laborers. Now they possess a distinct, profitable skill. In addition, members of this farmer group are part of an eponymously named co-operative from which they access loans with a preferential rate (6% annual) for vegetable production, thus further enabling commercial scale-up and practice.



e). Behavior change stimulated by hybrid seed use and plastic tunnels: one of the key indicators of farmers' changing agriculture practice, and orientation toward commercial production, is first their willingness to plant hybrid seed, and then their comfort level with the increased cost, care, and production typically associated with hybrid varietals. Both farmer groups and agrovets (interviewed as part of a parallel study) commented on the increasingly common use of hybrids, particularly for vegetables, which has significantly escalated in the last 2-3 years *(see photo at right – hybrid seeds are prominently displayed in agrovet stores).* Once farmers begin using hybrid seeds, they also typically begin purchasing other inputs in greater volume. As this escalation in expenditure is directly equated in the farmers' perspective with improved yields, they become gradually sensitized to the concept of 'growing their practice' through progressively increasing inputs. In some cases, this means taking additional land on lease to further boost production while more often it translates into farmers looking to other technologies that will enhance production on their existing plots. Aided by demos, many farmers in KISAN's coverage area have now been exposed

to production accelerating technologies, such as plastic tunnels, and with subsidies have incorporated simple technologies into their farming repertoire. A decade ago, farmers would have balked at the notion of spending Rs. 15,000 on plastic tunnels while now fields in vegetable pocket production areas in Kailali, Bardiya, Dang, Surkhet and Salyan, amongst other locations, are riddled with them.

It's worth noting that one of the groups, Bhagabati Farmer Group in Kapaleki, Doti had a negative experience with vegetable hybrid seeds. They are turned off by the increased care: "Hybrids require a lot of inputs and have ruined our fields," reported some of the group informants who are concerned not only about the damaged crops but also the lost input investment. It will require a big shift for this group to work with agrovets.

f). Farmer confidence linked to technical support and information: while farmers are becoming more open to trying new practices, and early adopters are becoming more adept with new technologies, there are still plenty of risks and external factors (e.g. pest, soil, climatic, irrigation, seed quality issues) that can impede progress and momentum towards commercial production. This is especially true for those farmers who have been more subsistence oriented and who need reinforcement to overcome obstacles and master new techniques.

According to the Chairman of the Ghattekhola Farmer Group in Barela, Salyan, who now farms with five plastic tunnels (including both subsidized procurements and personal purchase), before the irrigation support and training that he and his group received from KISAN he didn't sell vegetables in volume. As of a year ago, however, he's sold 400 kilograms of bitter gourd at an average of Rs. 50/kg; nearly 200 kilograms of tomatoes at the rate of Rs. 30/kg; 200 kilograms of cauliflower at the rate of Rs. 40/kg; 600 kilograms of cabbage at the rate of about Rs. 18/kg; 400 kilograms of onion at the rate of Rs. 60/kg; and 60 kilograms of chili pepper at Rs. 50/kg. This is a manifold increase in production, and profit, which he credits to practice, confidence, and increased area under plastic tunnel production.

The learning attitude of some groups is problematic in that they are hesitant to apply all of the new practices that they have learned and lack trust with technicians including AMTs and agrovets. The Rudhaula Vegetable Production Group in Tilaurakot, Kapilvastu fits this profile. The Chair commented that they listen to about 50% of agrovet advice. The members have experienced problems with their tomato crops the last two years in a row (apparently because of late planting) and use pesticide inconsistently. The AMT responsible for this group told them during the FGD: "you need to devote the same time and energy to caring for vegetables as caring for a pregnant woman".

***g). Pesticide application protocol*:** although KISAN has provided capacity development trainings with pesticide knowledge and application specific content to both farmer groups and agrovets, and project staff have spent considerable energy on developing a Pesticide Evaluation Report and Safe Use Action Plan (PERSUAP), there is still a need for continuous education and awareness campaigns.

Farmer group members were found to use varying pesticide application practices, as compared to program recommend procedure. This is likely a proxy indicator for varying awareness levels concerning concentration/volume of pesticide to be used, frequency of use, adherence to proper waiting period, and proper washing of vegetables before consumption.

Members of Navadurga Namuna Farmer Group in Shivapur, Kapilvastu are notable best practice examples of pesticide use. Their members wear long sleeved protective clothing, face masks and even

rubber boots as a precautionary measure. By comparison, the adult son of a member of another group visited in Kapilvastu (Rudhaula Farmer Vegetable Production Group, in Tilaurakot), demonstrated the typical attire/approach the group uses while spraying pesticide: he wore the spray can directly on his back with no protective layer, along with rubber sandals and no protective clothing while spraying pesticide directly ahead. When queried as to whether this group eats the vegetables they grow, or only sell them, they confirmed that they consume the same vegetables that they sell.

Some farmer groups openly talked about the need to use limited pesticides, and only when really necessary (e.g. Ghattekhola, Salyan). This may partially be due to agrovet advice (as the agrovet who supplies the Ghattekhola Farmer Group is leaning towards a more organic orientation and cautions his clients about heavy pesticide use). But it's worth noting that this group also been exposed to IPM content in numerous trainings provided by KISAN, NEAT, DADO, and IMP-IL, so are more savvy about dangers of chemical inputs (*refer to photo below – IPM-IL field information board in Salyan).*

One Ghattekhola farmer group member commented that organic production would be useful as the quality of the vegetables would improve, input costs would decrease, and the health benefits would be superior.

Others, such as the Mankamana Farmer Group in Urhari, Dang voiced the opinion that it's better to use organic inputs than chemical ones, and actually follow this practice. They don't use pesticide at all and find that there is a big demand for organic produce – people even come to their village on the outskirts of metropolitan Tulsipur to buy vegetables from them.

Interestingly, of the various KISAN training opportunities, the homemade bio-pesticide *jol mol* commanded little interest. Members of the Rudhaula Farmer Group in Kapilvastu summed up the reaction well: "ready-made pesticide works faster while *jol mol* takes a long time (to work)". The AMT commented that this group tends to use pesticide inconsistently (which ties back to their learning attitude and application of teachings).

h). Crop monitoring protocols: the number one customer complaint cited by agrovets in a recent field study revolved around seed germination issues. Some agrovets, such as Mourya Seed Center and Vet Pharmacy in Taulihawa, Kapilvastu recommend that farmers first test out seeds by closely monitoring germination before widely planting. As there are an abundance of seed providers and quality varies widely it is a prudent practice to scrutinize seed growth. Likewise, pesticide application is problematic for some farmers in that they find it difficult to determine appropriate concentration and timing per specific type of pest, and end up over or under-compensating. Not surprisingly, crop yields and consumer health can be negatively affected. This is tied to level of experience and applying critical analysis skills to make informed decisions. One of the AMTs in Bardiya mentioned that the biggest technical constraint with farmer groups there revolved around appropriate use of chemical fertilizer. Clearly, as farmers move in a commercial direction with greater use of inputs, their crops are responding differently, and in sometimes unexpected ways, than traditional farmer practice. Crop monitoring skills would be a useful component of a 'continuing education' style field course, especially relevant as linked to IPM content and training practice (e.g. farmer field school).

i). Limited business skills: while farmers' technical agriculture skills are improving, and they are accessing a variety of inputs and technologies (e.g. plastic tunnels), their business skills are not increasing at the same rate. Farmer group members across the board have difficulty conducting cost/benefit analysis concerning cost of production vs. profit. Fortunately, under KISAN the groups have been instructed to maintain crop production diaries and most seem to follow this practice (*see photo below of Kapilvastu District Coordinator and AMT reviewing crop diary with members of Navadurga Namuna Farmer Group).* Crop production diaries were not cross-verified for accuracy and it's not clear that farmers use the diaries as a tool for planning and understanding their business practice as much as a record of inputs and outputs.

Certainly this is a good start but further technical support is needed so that farmers can use their crop data to inform their business practices. This is especially important for farmers who are increasing their production and becoming more commercially oriented.

There are a lot of stumbling blocks to navigating the business world and while many farmer group members are also co-op members and can access a range of resources (e.g. loans, savings accounts, fertilizer), they have blinders on as to many existing opportunities and linkages. For example, after receiving a package of trainings and irrigation support from KISAN, members of the Aakuwa Farmer Group in Joshipur, Kailali have been rapidly increasing their production. Yet they are now stymied by market access and transport of their vegetables. KISAN is supporting development of a nearby Market Collection Center but the farmers realize that there are a variety of markets and wholesale buyers and they don't want their profit limited by the convenience of a nearby purchaser who gives them lower prices. They're also concerned about transporting their produce on tractors which, given the rutted condition of unpaved roads, can damage the vegetables. On more than one occasion during the visit group members requested support for a vehicle for them to use to transport their products.

The Chairman of Rudhaula Farmer Group in Kapilvastu summarized the gap between farming and business well: 'We're farmers, we don't keep track of profit or expenses." Ultimately though, if farmers want to transpose their traditional livelihood into a viable income generator, they're going to need to acquire a better grasp of market dynamics. This will require technical support.

j). Preferred KISAN trainings: the groups overwhelmingly cited nursery as their favorite training. A number of them commented enthusiastically on line planting - "before it was random" (*refer to photo below of nicely planted cabbage fields);* use of compost fertilizer and, not surprisingly, plastic tunnels were also mentioned prominently. The latter were not adopted immediately, however, as there is a substantial cost barrier. The fact that farmers are now buying non-subsidized plastic for tunnels attests to their faith in this approach. The Chairwoman of Sayapatri Farmer Group in Barala, Salyan commented that she's earning more money from plastic tunnels than her husband who's working in the Middle East. Apparently, he's going to return home soon and re-engage with agriculture along with his wife.

While not a scientific assessment, places where plastic tunnels demos were held seemed to have a launching effect in that farmers could see firsthand, and monitor over the course of a season, the very visible effects of increased production; and then adopt the technology themselves. Plastic tunnels are a behavior changing stimulant that help farmers think about crop production cycles differently which, in turn, causes them to examine their practices more closely (as opposed to traditional practice which is not analyzed as much as simply followed).

Members of Sita Ram Farmer Group in Surkhet have enthusiastically adopted plastic tunnels, along with other innovative approaches such as a use of a solar pump (*refer to photo below, displaying a plastic tunnel demo banner*). The success from increased production and sales is driving some of them to experiment with other technologies (e.g. Israeli drip irrigation) which they hope to further fuel crop improvements.

k). Benefits of farmer group registration: KISAN staff have made a concerted effort to get farmer groups registered with DADO as this linkage opens up a number of benefits. For example, groups can access reduced cost materials, get training opportunities, and for the purposes of irrigation DADO is one of the line agencies that endorses applications to the Electric Authority for subsidized electricity rates.

l). Irrigation Operation & Maintenance functions: all groups that were supported with irrigation schemes also received an Operation and Maintenance (O&M) orientation (*refer to Annex VII for irrigation training guidelines).* The length and depth of these orientations varied, probably due to group and staff interest, but typically lasted at least 1-2 hours. During the orientation groups were encouraged to raise funds for the sustainability of their scheme. In practice they take slightly different approaches to O&M depending on their irrigation facility and needs. Some groups collect a monthly maintenance fee from households within the group that benefit from the water.[18] Amounts range from Rs. 10 – 100/month. Use fees are also levied, sometimes with a bit of padding which is channeled to the O&M Fund. For example, Milan Farmer Group members in Bardiya get equal water access and pay according to the number of electricity units used plus Rs. 10/hour.

Five of the groups visited do not maintain an O&M Fund (one in Kapilvastu, two in Salyan, one in Surkhet and one in Doti). As O&M costs often revolve around pump operation and repair it's not surprising that only one of these groups has a pump which they purchased on their own (no KISAN subsidy); they have a small amount of money left over from the purchase and commented that this can be used for future repairs. The more collective a group's interest, the more willing they are to raise funds for O&M costs.

[18] Given the location of the improved water source, it's not typical for all members to directly benefit from the scheme.

For example, the Hareyeli Women's Farmer Group in Kailali is involved in a group production effort and thus has no problem with raising funds. Conversely, a number of members of the Rudhaula Farmer Group in Kapilvastu own their own pumps and rent them out to others in the community (KISAN irrigation support to this group focused on drilling a shallow tube well).

The groups in Salyan and Doti foresee little in the way of potential costs arising for O&M and are reluctant to part way with cash for an insurance policy that they do not see as relevant to their irrigation scheme. Interestingly, at least three of these groups made expressions that reflect their dependent attitude: the chairman of the Rudhaula Farmer Group commented that he wasn't interested in participating in an upcoming field training if food wasn't going to be served (in response the DC asked him if he was 'interested in knowledge or only food') and the father of one of the members of the Laligurans Farmer Group in Salyan commented that if they have O&M issues (for which they are not saving money), they'll make a request to 'father (KISAN) to help more. When a child cries for milk it gets it." One of the groups (Ghattekhola in Salyan) has a backup plan in that they will raise funds on a ropani/ volume of use basis.[19]

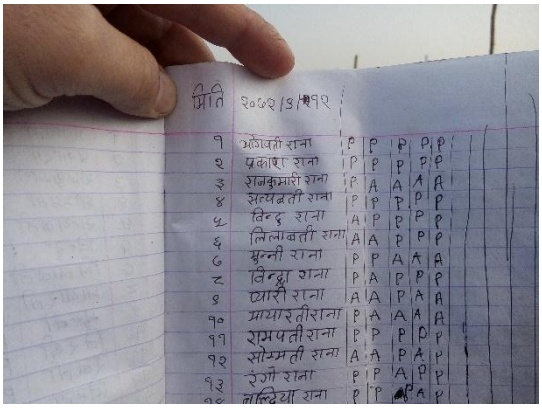
Even with groups that raise funds proactively there is some question about the ownership of their materials, specifically the pumps. Some groups remarked that the only maintenance they had incurred was for oil which is really more of an operational issue but can be seen as appropriate preemptive maintenance. Other groups were encouraged by the AMTs and ITs to regularly add oil. A couple of good practices emerged in regards to O&M fund recovery: some of the groups levied greater fees from non-members, sometimes significantly larger. Manakamana Farmer Group in Dang, for example, charges members Rs. 22/hour (fuel not included) while non-members must pay Rs. 100/hour.

The fund supply obviously depends on such factors as number of people contributing and amount of fees collected, but none of the groups commented on challenges associated with paying for repairs or general maintenance. This may well have to do with the fact that most of the pumps are fairly new and despite solid use are all working.[20] Regardless, charging reasonable fees in excess of usage cost is a smart recovery option. Another good practice is being employed by the Nava Durga Farmer Group in Shivapur, Kapilvastu in the form of assigning pump and distribution pipe responsibility to specific members of the group who are allowed to collect agreed upon operator fees.[21] This practice ensures that the machinery and equipment is kept in good condition and that people are available to rotate the distribution pipes and ensure equal access for members. Case studies that further explore irrigation system good practices would be useful.

***m). Farmer group regulations*:** The farmer groups clearly serve many functions, but their level of organization and self-regulation are indicators of seriousness and sustainability. Some groups levy fines for late payment of group fees and even for attending meetings late, or worse, for not attending meetings at all. The Hareyali Women's Farmer Group documents attendance (*see attendance roll photo*

[19] One ropani = 5,476 square feet.
[20] As part of the FGDs, irrigation schemes were also examined and wherever possible water sources were investigated.
[21] With the proceeds of the O&M fund they pay an operator Rs. 400/day x two operators (to move the pipe around etc.); or on an hourly basis they must pay Rs. 50/person and snacks.

below) for their group farming efforts. This also serves a conflict mitigation function. Systematizing their practice through documentation and group regulation holds members more accountable.



Even if they are not engaged in efforts, such as collective farming, that affect all members equally, there is a correlation between those groups with more dependence on cooperative functions (e.g. maintaining an O&M fund) and group solidarity. This, in turn, appears to influence the reinforcement of new technical learnings at both the group and community level. In other words, behavior change is reinforced by group practice.

n). Presence of savings & credit: although the groups were not specifically queried about savings and credit activity, a number of them raised this topic when discussing the O&M fund. Even some groups that are not saving money for O&M were found to be collecting cash for their revolving fund (with the exception of one group in Kapilvastu that seems to be an outlier in many regards). Group regulations varied as to savings/loan amounts and interest with some charging rates of up to 26% annually, but clearly the groups are interested in accessing money from additional sources; they mostly seem to be using the loans for vegetable production. Three of the four groups that talked about savings and credit activity also mentioned being part of a local co-op (overlapping membership) where they deposit the funds, and are able to access preferential services, such as fertilizer and low interest loans (e.g. 6%) for vegetable production. The mechanics of group saving and credit activity were not explored in depth.

o). Resource conflict: Conflict over access to water, pump use, or operation didn't come up in any of the FGDs. When questioned about the issue, groups invariably responded that it's important to pre-empt conflict and to take care of any problems that might arise, so as to prevent conflict. There are a number of built in regulators to KISAN's irrigation scheme selection process, such as avoiding schemes that straddle VDC borders; and not providing support if there is any dissent among farmer group members. Rotating access to water is a common practice of the groups. This equity promoting and conflict mitigating practice is a focus issue in the O&M orientations.

Members of Bhagabati Farmer Group in Kapaleki, Doti mentioned a positive side-effect of their rehabilitated canal as a conflict inhibitor in that it's easier for people to divert water from a damaged canal, thus causing conflict. Other factors that may explain lack of conflict over water include the fact that in some places there are other sources of water nearby - not all dependent on one source; and that people are able to access sufficient volume of water from the new source. The latter may be an indicator that groups have not reached solid commercial scale yet as this would require dedicated, volume access. However, some of the groups mentioned accessing water at night when they needed to, and others mentioned priority rotation according to production land size.

p). Pump issues: three distinct types of pumps were found to be in use including, from cheapest to most expensive, electric, diesel and solar. In Year 3 more than double the number of electric pumps were provided than diesel ones (23 vs. 10) while only three solar schemes were supported. In Year 4, of the 190 schemes implemented up through February 2016, nine are diesel pumps and six are electric. There are pros and cons to using both, depending on the needs of the specific groups and available budget. The biggest advantage for electric pumps is their affordability, particularly Chinese models (though they

reportedly break down more often - as a result, of the electric pumps KISAN supported, 100% are Indian models[22]). For diesel pumps the Chinese models are also much cheaper (around half the cost of Indian versions), and typically much lighter than Indian models which facilitates movement. Solar is ideal but the cost is dependent on motor power which is directly related to how far the water must be pumped including the vertical distance from the source.

The groups that have been using electric pumps commented on a number of negatives including: dependence on the electric grid which is subject to significant loadshedding hours, especially during the winter and pre-monsoon spring months, as well as periodic unscheduled cuts which further decrease supply; in the Terai during peak electricity consumption period (hot season), there is an extremely low voltage supply which is not sufficient to operate the pumps for extended periods of time. Likewise, during the embargo diesel was difficult to access and the cost increased. Although none of the groups expressed concern with the impact of loadshedding on group rotation, in regards to stimulating conflict, some groups mentioned the possibility of renting diesel pumps if an emergency arose.

The fluctuating electricity supply affects pumps differently. There are two basic qualities of electric pump – high voltage and low voltage with the latter commanding a significantly higher price (approximately Rs. 2,000 – 3,000 more). The problem lies with the typical low voltage electricity supply in the Terai which burns the pump coil on high voltage models. Thus it is preferable to use low voltage pumps, ideally of Indian Standard.

Wherever groups had motorized pumps as part of their irrigation system they were asked to start the pump. All of the pumps checked out in terms of operation and pulling water. In one case, however, the members were unable to physically start the machine. Hareyali Women's Farmer Group, as the name attests, is comprised of women who are involved in what appears, so far, to be a successful collective vegetable farming practice. Strangely enough, none of the women felt comfortable hand cranking the diesel pump and it emerged that a male relative of one of the members was typically tasked with this operation, along with record keeping, and securing inputs. Considering that the pump is not so difficult to start (this consultant did it), and that the location of the vegetable plot is about 20 minutes walking distance from the members' village it calls into question the regularity of the man's involvement with the group and how this affects their work (maybe he's paid?). At the very least, there are additional capacity development and empowerment opportunities for this group which would nicely complement their skillful agriculture practice.

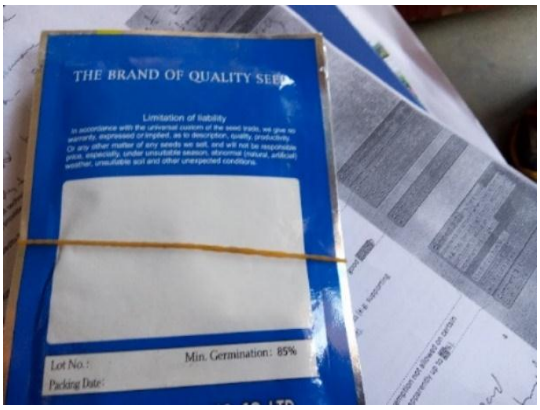
q). Scope for solar: while the large solar panel irrigation system in Surkhet, highlighted in the earlier success story, is impressive, it is also expensive costing a total of Rs. 520,000. Many, if not most, farmer groups will not be able to leverage sufficient resources, or be willing to spend their own money on such a system, even if the benefits ultimately outweigh the upfront investment. Other, more affordable solar schemes were seen while visiting a farmer group in Bardiya, principally in the form of a small, mobile solar pump (*see photos below*). This one horse power model is more suitable for shallow tube wells that

[22] CRI, Crompton, Oswal, Kirloskar, Lubi, and KDS are the Indian brand electric pumps used in KISAN.

do not require significant power to lift water. The pump's portability and cost (Rs. 40,000), however, is a major attraction for farmer groups.

Another significant advantage of solar pumps is that, besides occasional cloudy weather, it's difficult to block the sun. This is notable in the context of complaints by farmer groups about pumps operated by other energy forms (e.g. electric issues with loadshedding and low voltage supply, as well as diesel/petrol shortages caused by the Indian embargo). Solar is appropriate for different settings but especially for more rural hill areas where there is no electricity supply and fuel is expensive and/or difficult to access. Although credit purchase options weren't available when the Sita Ram Farmer Group secured their solar pump system, they are now which should facilitate other sales.

r). Input quality: farmers are purchasing a variety of inputs but the quality varies. Some of the farmer groups, such as Ghattekhola, Salyan, specifically commented about experiencing seed germination issues. They get their inputs from Srijana Agrovet whose proprietor also remarked on the same topic in a separate interview. While truthful labelling is important, quality control monitoring is lacking along the distribution chain (*see photos below: note the lot number and packing date of the seed packet on the right has been erased which suggests that it is date expired*). There are also chronic issues with chemical fertilizer in terms of accessing sufficient volume, as well as quality.



RECOMMENDATIONS

A menu of options for going forward, corresponding to findings detailed earlier in this reports, are listed below.

BEST PRACTICES AND LESSONS LEARNED

- **KISAN Irrigation policies – documenting and applying best practices**: by March 2016, 640 irrigation schemes covering 1,815 hectares had been supported, affecting 10,770 households. An estimated additional 560 irrigation facilities will be implemented before KISAN ends. Documentation of lessons learned and what's working best would be immensely useful in informing implementation of new schemes and assessing whether the most appropriate and cost efficient technologies are being used. Relevant topics of focus for documentation include the implementation process angle, such as the most appropriate technology forms used in different environments as well as leveraging of support; and the results side - especially case studies - of how irrigation has impacted communities, and potentially motivated them to undertake new and diverse farming practices.

- **Farmer group management best practices:** it would be instructive to explore and document best practices around group irrigation management, such as group regulations and fund-raising approaches; and assigning responsibility of irrigation system maintenance and operation to individual group members with cost recovery.[23] Other non-irrigation related best practices can be promoted as well as, such as encouraging farmer groups to procure inputs in bulk as typically they can access discounts for volume purchases. The more commercially oriented the group is they may be able to even secure large discounts. Surprisingly, all of the groups are not taking advantage of such procurements. In addition, it's worth highlighting the role that KISAN farmer groups are serving as community role models and change agents. For example, the Aakuwa Farmer Group in Kailali mentioned that non-group members are requesting them to also sell their vegetables as the group is growing and collecting sufficient stock for volume sales.

- **Understanding drilling costs:** One lesson learned from implementation of irrigation activities is that cost estimates and *mistrie* contracts for shallow tube well drilling vary according to district water situation in the Terai and district office practice. For example, in Dang's Deokhari Valley[24] drilling up to 45 feet usually takes the form of a 'hammering' technique at a cost of Rs. 10,000, while in Banke the cost is normally Rs. 7,000 for a 'pressure load' technique drilling between 40-50 ft. Before determining budgets and establishing targets for irrigation support it would be useful to convene local *mistries* to map out types of land in the project area and costs involved for drilling. This practice was also carried out by the USAID funded NEAT project. While drilling

[23] Many of the groups operating electric pumps had secured a subsidy from the Electric Authority which reduced their electricity rate by 50%. The process entails getting a recommendation from the VDC, Agriculture Support Center (Sewa Kendra), and finally the application is endorsed by DADO before being forwarded to the Electric Authority. A best practice write up on this approach that details learning on how to expedite the process would be useful.

[24] Dang, Kailali and Kanchanpur share similar soil composition and thus also boring techniques.

it's best to have farmer groups present and providing feedback to the *mistrie* so that drilling is carried out to the proper depth inclusive of a 10 ft. filter layer.[25]

TECHNICAL SUPPORT AND EDUCATION FOR FARMERS

- **Continue technical support for farmer groups:** as farmers move towards a commercial orientation they will need continued technical support that addresses a variety of problems that arise over a season. They need a cushion to take risks and test out new practice. Season long demonstrations complemented by technical instruction once per week, such as in a farmer field day environment, would be a practical approach. Technologies and new practices can be delivered at appropriate time of the season in the extended training and farmers can investigate, analyze and get in-time feedback on approaches which they may harbor doubts about (e.g. efficacy of bio-pesticide), or not have sufficient confidence to try on their own. An important component of this service delivery option would be to engage and train agrovets as LSPs. Instead of paying them a fee, it would be preferable to make an arrangement whereby the agrovets provide trainings to multiple farmer groups as cost share, thus increasing their interaction, and inevitably relationships and sales with the individual farmers. By focusing capacity development on a select number of agrovets in each district, they will then be the catalysts for farmer capacity development, including linking farmer groups to other support services and resources.

  Season long demonstration plots are an ideal venue to distribute supplementary resource materials so that farmers have reference information to use on their own, with appropriate diagrams. The season long training could take an IPM focus (so as to reduce inputs and focus on pest identification and control) while piggybacking on or incorporating new technologies. Training classes would ideally be held once/week in the early morning which should work best for farmers and agrovets alike in terms of free time, and is also the optimal time for pest identification. The IPM training would take a comparative approach so that farmers can see how their traditional practices are faring against new practice. In order to be cost effective lead farmer representatives from a number of groups in a catchment area can be included in a single training.

- **Collaborate with private sector and GoN for demos:** getting cost share for demos would further promote sustainability and expand farmer training opportunities. One potential company to approach is Agriplast which operates 'Centers of Excellence' – demo sites that model multiple farming approaches and technological inputs, side by side. Although an Indian based company (with centers of excellence in nearby Bihar amongst other locations in India), they have representatives with extensive experience in Nepal (www.agriplast.co.in). The Asia Innovative Farmers (AIFA) Project is currently exploring a partnership with Agriplast and KISAN could potentially piggyback on this approach and encourage a broader, private/public partnership by engaging relevant GoN agencies such as DoA and NARC. Already DADO supports

[25] In some places a 10 foot filter will not be accessible and a multiple well type system will be utilized incorporating more than one inlet but only a single outlet.

some demos in KISAN districts. Multi-stakeholder support for demos could go a long way towards scaling up successful approaches and promoting interaction between agrovets and other key agriculture sector actors which will further benefit farmers.

- **Exposure visits:** continue to provide exposure visits to farmer group members, even if only to nearby VDCs (at least expose them to different conditions/crops/technologies/approaches). A key focus of such visits should be interaction with other farmer groups that are capitalizing on specific value chain opportunities, such as seed production, as well as with a variety of market actors (buyers, collection centers, agrovets etc.).

- **Further develop education and awareness campaigns on safe pesticide use:** to reach a 'tipping point' where farmers are undoubtedly clear about safety of both application of pesticides and consumption of pesticide laden vegetables will require further education. On a practical level this information can be reinforced by integrating in technical trainings. On a broader level it would be useful to develop an information campaign that incorporates both educational content and awareness of the penalties involved in selling vegetables with high pesticide concentrations. A digital platform would be ideal to disseminate messages, such as through brief video clips which can be distributed to farmer groups, schools and potentially co-ops in the vicinity of supported farmer groups, DADOs, and supported agrovets. As most staff have video applications on their phone they can shoot brief clips which can then be used as part of the trainings and information campaigns, particularly concerning farmer practice, such as with pesticide application. KISAN staff can also carry laptops to the field and provide farmer groups with instruction in the form of direct feedback on the video clips which people will be interested to watch and comment on.

  In addition, it would be worthwhile reaching out to DoA/DADOs and ideally partner with GoN for an education/awareness campaign around pesticide use and health implications. As part of a public outreach effort to amplify the campaign KISAN could also organize a competition targeted at high school youth to develop 'messaging' visuals for the campaign, with a prize for best entries. There are plenty of existing graphic materials on pesticide use but enlisting students, at least in project areas, will ensure that the messages are disseminated more broadly.

  Private sector actors, such as NIMBUS, Agricare and potentially even large agrovet regional wholesalers, can be approached to sponsor prizes (and get free publicity in return). The graphics would focus on key themes such as importance of: limited pesticide use, appropriate application timing, and understanding proper dilution ratios; safe spraying practice including wearing complete protective clothing; and, significantly, a consumer safety angle including proper washing of vegetables, along with threat of punitive action for farmers who supply vegetables with high pesticide levels.

- **Expand business literacy and business development support:** An intermediate level business management module would be useful to integrate into technical trainings. It would be beneficial for some part of this training, which would need to be spread over a period of time/sessions in order to be effective, to be provided by agrovets as they also need to develop superior business

planning and management skills. A cascade training with specific topics geared only at agrovets and other topics geared at farmers can be incorporated in a Training of Trainers curriculum for the agrovets, thereby building capacity of both groups simultaneously, and with lower cost.

An increased emphasis on farmers' documenting their input purchases, vegetable sales and other relevant transaction costs, such as hired labor, is important. Significantly, capacity development should focus on accurate documentation as well as on how to analyze and use the information with the ultimate objective that farmers should be able to carry out a cost/benefit analysis. Utilizing a production diary in the form of a seasonal calendar would be a good entry point to work with farmer groups in interactive sessions focused on planning the full spectrum of pre-production to post-harvest activities.

MONITORING

- **Water quality/systems monitoring**: the focus of KISAN irrigation support has been on implementation but the quality of the water farmer groups is accessing is not clear. In hill districts concentration of lime could potentially be an issue while in the Terai there are problems in some areas with arsenic. The water quality issue was raised by Toyanath Pandey from DEPROSC (the partner responsible for irrigation activities) in a briefing on irrigation study findings. As a post implementation issue it doesn't seem that the Irrigation Technicians (ITs) spend much, if any time, in follow-up with schemes once the support has been provided and O&M orientation completed. The most feasible approach to monitoring the supported schemes may be to assign responsibility to AMTs who have extended contact with the groups. They, in coordination with the ITs and Irrigation Expert, can develop a monitoring mechanism and make recommendations for any necessary technical follow-up support that is beyond their capacity. Considering voltage fluctuation it's also worth exploring the use of volt guards to protect the pump investment.

ADVOCACY

- **Seed quality monitoring:** although it may be beyond the scope of the project, an advocacy campaign for increased monitoring (along with fines for violations) of seed distributors would be immensely useful. On a more individual level, it's important to work with agrovets so that they, in turn, can apply pressure on wholesale suppliers to analyze their own supply chain. Farmers also need to be encouraged to closely monitor seed germination and if timing is not right they need to act quickly and demand replacement seed (this recommendation was echoed by agrovets who cited their number one customer complaint stemming from seed germination issues). It's also important to advocate with GoN to increase their monitoring and oversight role.

MEASURING IMPACT

- **Mini-survey to explore impact of irrigation:** the starting point for determining quantitative and qualitative impact of improved irrigation systems on agriculture production would be a mini-survey. The survey tool should tease out indicators of impact and farmer orientation, such as increased production, whether the irrigation is enabling commercial production, as well as volume/cost of inputs purchased by farmers. Modified cropping patterns (e.g. wheat being subsumed by off-season vegetable) are another important consideration. In order to understand influencing factors the survey should examine size of production area, crops planted and cropping intensity, regularity and volume of water typically accessed and cost (e.g. user/O&M fees). Finally, yields and production costs should be compared before and after KISAN supported irrigation systems came online. There may not be room in the survey to investigate farmers' attitudes regarding purchase of water but this would be useful information to understand, particularly as farmers increase their production area and run into water supply and/or pump limitations. Some farmers, as they max out production on their own growing area are turning to leases to acquire more land. As water is a catalyst for profitable off-season vegetable production it would be interesting to document water purchasing trends and analyze where individual farmers' water investment threshold lies.

SUSTAINABILITY

- **Reducing subsidy mindset:** some of KISAN's irrigation practices, such as requiring farmer group leverage in Year 4, are important for promoting ownership of irrigation schemes and sustainability. Demonstration sites will remain important avenues for modeling new technologies and approaches but reducing subsidies and replacing them with other value added approaches is one way to undercut the dependence on subsidies. For example, engaging agrovets **without** a fee to serve as LSPs for demo sites with the explicit understanding that they will benefit from their relationship with farmer groups. As the project winds up in Year 5, it's essential to think about promoting KISAN best practices that will survive without the benefit of subsidies.

- **Other practices to promote sustainability:**
  - It's worthwhile compiling a list of technical support service providers, by area, with specific expertise amongst the ranks of individuals or companies that KISAN has had a positive experience with and share with farmer groups. This list could include agrovets and other LSPs, machinery and irrigation parts suppliers, *mistries*, hardware stores etc. Although it would be wise to avoid officially endorsing an individual business, a focus of the list could be on commercial entities that are 'field friendly' and provide information and follow-up service.
  - Compile a list of linkages that KISAN has facilitated (e.g. farmer group registration with DADO; recommendations to DADO for irrigation support; support for MPCs; connecting farmer groups with foundation seed suppliers and other private sector entities etc.). These lists should be shared across districts and AMTs can provide copies to farmer groups to give them ideas and simulate questions in regards to how to access different resources.

- Develop case studies on sustainability focused topics that can be utilized by different audiences including USAID, Kathmandu management, and district management. A case study of the benefits of group registration with DADO would be a good start (e.g. access to materials and training and other government resources).
- Farmer Groups need more information about how to access other, non-KISAN resources. A group networking or workshop approach involving Chairs from different groups, held in different VDC clusters, so that they can share experiences and learn about opportunities including regularly available (GoN type) resources would be useful. Resource mapping could be one of the workshop activities. Some of the 'best practices' emanating from the workshops could then be written up and shared with farmer groups and agrovets as part of a resource package.
- When buying electric pumps It is preferable to use low voltage pumps, ideally of Indian Standard, which should be longer lasting than Chinese models.
- In an effort to optimize the remaining irrigation budget KISAN should consider prioritizing schemes according to number of beneficiaries accessing the water, and communities that have access to few other water resources.

ANNEX I

Table 1. Farmer Group Focus Group Discussion List

S.N.	Name	Location/District	Date of FGD	Type of Irrigation Support	Year of Irrigation Support
1.	Bhagabati Farmer Group	Kapaleki VDC #9, Doti	January 17, 2016	Canal rehab	Y3
2.	Chandeshwhor Farmer Group	Warpata VDC #4, Doti	January 16, 2016	Pipes & sprinkler	Y3
3.	Hareyali Women's Farmer Group	Geta VDC #9, Rajapur, Kailali	January 18, 2016	Diesel pump	Y3
4.	Aakuwa Farmer Group	Joshipur VDC #7, Kailali	January 19, 2016	Electric pump	Y3
5.	Milan Farmer Group	Kalika VDC #3, Bardiya	January 22, 2016	Electric pump & pipe	Y3
6.	Sita Ram Farmer Group	Taule, Ward #10, Chinchhu, Surkhet	January 23, 2016	Solar pump	Y3
7.	Sutabari Farmer Group	Sutabari, Surkhet	January 23, 2016	Distribution pipe	Y3
8.	Bardka Farmer Group	Sathbariya VDC #2, Banghusari, Dang	January 25, 2016	Irrigation channel support	Y3
9.	Kamalnayan Farmer Group	Sathbariya VDC # 5, Dang	January 26, 2016	Diesel pump	Y3
10.	Mankamana Farmer Group	Urhari VDC # 5, Dang	January 26, 2016	Diesel pump	Y3
11.	Laligurans Farmer Group	Rim, Salyan	January	Plastic pond	Y3
12.	Ghattekhola Farmer Group	Barala, Kajeri VDC, Salyan	January 28, 2016	Canal support	Y3
13.	Sayapatri Farmer Group	Barala, Kajeri VDC, Salyan	January 28, 2016	Canal support	Y3
14.	Navadurga Namuna Farmer Group	Hallanagar, Shivapur VDC #5, Kapilvastu	January 30, 2016	Diesel pump	Y4
15.	Rudhaula Farmer Group	Tilaurakot, Rudhaula, Kapilvastu	January 31, 2016	Shallow tube well	Y3

ANNEX II

Table 1. Irrigation Scheme Implementation Steps

Steps	Activity	Remarks
1.	Identification of potential farmer groups for irrigation support.	Irrigation technicians (ITs) work together with AMT on needs identification.
2.	Prioritize the irrigation demand.	Prioritization determined in monthly staff meeting in district (the greater the number of households benefiting the better; leverage from other partners also contributes to prioritization as well as level of potential commercialization).
3.	Feasibility study.	IT carries out together with AMT.
4.	Report submitted to Irrigation Engineer and District Coordinator (DC).	IT submits the detailed report of feasibility study with recommendation for proposed scheme.
5.	Irrigation Engineer and DC make decisions based on the report's finding.	If report accepted the scheme moves forward (it should be made clear to farmer groups that they will not be eligible for KISAN support for more than one scheme).
6.	Formal irrigation scheme request letter by farmer groups to district office.	Farmer groups submit request letter with beneficiary signatures to KISAN office in respective districts.
7.	Identify and fixed the irrigation installation land area.	Based on technical feasibility IT, with support of farmer group, organize the land area and get the acceptance/ agreement of land owners for providing their land for the installation of irrigation scheme. It should be clearly mentioned how long the land will be available to host the irrigation scheme. This information is reflected in the installation scheme agreement.
8.	Collection of cash and in kind resources - required for installation of the scheme.	Available local materials (e.g. sand, stone, aggregate) are collected around irrigation site and other materials are procured through quotation by User Committee.
9.	Agreement is made with farmer groups for the installation of irrigation scheme.	Land for irrigation installation, cost sharing, vendor for material procurement, selection of skilled labor, repair and maintenance fund all are described and finalized in agreement paper and this is signed by chairperson of group and IT. Project contribution is also mentioned in the agreement.[26]
10.	Implementation starts.	Depending on type of scheme it is typically completed within a one week to one-month timeframe.
11.	Submission of completion report.	IT submits the completion report to DC, Irrigation Engineer and Finance department.[27]
12	Operation and Maintenance training conducted with each farmer group.	All groups receiving irrigation support will receive a training on repair and maintenance, proper use, conflict management and smooth operation of scheme.
13	Follow-up and monitoring.	IT, AMT, Irrigation Engineer follow up and monitor the completed scheme.

[26] In case of fragmented land, two schemes within the allocated budged can be supported if all the group members agree and the agreement is documented.

[27] Once the scheme is completed a public audit should be carried out so that there is transparency on irrigation scheme budget, and expenditure. The audit should be carried out in the presence of all farmer group members, project staff, local government representatives, and other line agencies representatives working in that VDC.

ANNEX III

KISAN Promoted Irrigation Technologies

KISAN has been implementing the following appropriate irrigation technologies. The KISAN contribution is only for materials, tools and small equipment. Within the budget limit, district offices can plan and support more schemes/activities.

A. Support for new schemes/activities

1. MUS:

Two broad categories of water use:

a) Domestic (drinking, washing, sanitation)

b) Productive (irrigation, livestock, fisheries and other water based enterprises)

Multiple Use water System, is designed to simultaneously meet both domestic and productive needs. The main difference between water source for MUS and other irrigation schemes is that the water must be of superior quality for the former (e.g. fit for human consumption). Thus, typically MUS accesses water from springs. In MUS the first priority is for domestic use/consumption and the overflow from storage tank is then directed to a separate holding tank which is for productive use. MUS are appropriate for hill districts as water is channeled by gravity flow.

Figure 1: MUS

2. Water Harvest Tanks

Selection of location for plastic ponds/different types of tanks is done according to the following criteria:

- Close to water source.
- Stable ground free from threat of landslide or land settlement.
- Not prone to damage by flooding.
- Easy to deliver overflow and waste water.
- Appropriate height and distance from irrigation field.
- Not near to big trees as roots may cause problems.
- Flat as possible area.
- Not located in filled type soil.

2.1 Plastic Ponds

Plastic ponds of different sizes were constructed where feasible in hill districts (*refer to Figure 2 below*). Size of the pond depends up on the yield of water and the size of construction site. Size of ponds may vary from 20 cubic meters to 120 cubic meters. Farmers are responsible for the small sized HDPE pipes to deliver water from pond to the individual farmers' fields through symphonic action. Plastic, possessing the following characteristics, will be used for the construction of the ponds. 120 and 150 grams per square meter (GSM) plastic will be used.

- It should be Silpaulin quality (produced by Suprime Industries in India) with the following characteristics:
    - Available in 45, 70, 90, 120, 150, 200, 250 and 300 GSM.
    - 6-7 times stronger than other local plastics (refers to Silpaulin quality).
    - Made from Switzerland technology and IS14611-1998.
    - Available in different sizes.
    - Available in different colors including natural, blue, white, olive, green, and yellow.

Plastic ponds were more widely implemented in Year 3 as they fit the available budget. However, there are a number of vulnerabilities with ponds: fences must be erected to keep out animals and children; there is a limited lifespan of the plastic due to solar as well as rodent damage (when dry); and with earth movement plastic can be damaged by stones, contributing to seepage. Liability is a significant concern. With increased irrigation budget in Year 4 stone masonry, ferro cement, or soil cement tanks will be used instead of plastic ponds.

Figure 2: Plastic Pond

2.2. Modified Thai Jar (MTJ)

This form of water storage tank is most useful in the hills where water sources provide a limited volume of supply and distance from members' fields is greater (so that they cannot equally access a central storage tank), and where uneven terrain prevents placement of larger storage tanks. MTJs have only been supported in two districts – Gulmi and Arghakhanchi (*refer to Figure 3 below*).

- Size (1.5 and 3 cubic meters)

Figure 3: Modified Thai Jar

2.3. Soil Cement Lined Tanks

Smaller in size than the typical plastic pond, this approach also utilizes a mostly underground storage tank which is comprised of mixed earthen matter and cement, and extends ½ meter in height above the ground. The opening of the tank is covered by wire to prevent accidents and is further covered by corrugated iron (CGI) sheets to prevent water evaporation (*refer to Figure 4 below*).

- Size (6 and 10 cubic meters)

Figure 4: Soil Cement Tank

2.4 Stone Masonry Tanks

Where there is a greater volume of water discharge in hill areas as well as good supply of stone locally available, this type of storage is preferred. Tank sizes range from 15 cubic meters to 50 cubic meters. This is a gravity fed system which relies on pipes to carry water from source to storage tank and then separate delivery pipe to channel water to farmers' fields. Standard height above the ground is 1.5 meters and the top is covered by rod cement concrete (RCC) for smaller sizes and CGI sheet for larger sizes.

2.5 Ferro cement tank

Fully enclosed by concrete these storage tanks are built in a range of sizes from 1-20 cubic meters. However, from a cost efficiency perspective ferro cement tanks are constructed from 3-10 cubic meters

with KISAN support. Less than 3 cubic meters, Modified Thai Jars are less expensive to use, and greater than 10 cubic meters stone masonry tanks are used.

3. Shallow Tube Wells

A hole which has been dug, bored, driven or drilled into the ground for the purpose of extracting water is a well. A well is considered to be shallow if it is less than 50 feet deep (*refer to Figure 5 below*). All districts of the Terai are underlain by shallow aquifers that can be exploited for irrigation. This is the most common irrigation scheme supported by KISAN in the Terai where the average command area per well is 4 hectares. Water is distributed to farms by means of flexible delivery pipes which avoids the need for canals.

The cost of the shallow tube well directly depends on the depth of boring. The following materials are required for installing a shallow tube well.

- PVC/HDP/MS pipe.[28]
- Reflex valve.
- GI Elbow.
- GI Nipple (6" long).
- Suction pipe.
- Filter.
- Sealing materials (thread tape, putting).
- Diesel motor.
- GI bend for motor.
- Delivery pipe

In addition, extra installation charge will be necessary and this rate varies from one place to another.

Summary of shallow tube well technical features installed under KISAN:

- Size of boring – ideally 4" (it may also be 3" in case of water level)
- Required pump capacity (5 HP for diesel pumps and 2 HP for electric motors)
- Discharge - average 15 lps (corresponding to 3" boring)
- Motor size: 4" inlet x 4" outlet (for diesel) and 3" x 3" (for electric)

4. Canal Rehabilitation

- Rehabilitation and upgrading of existing schemes is limited to improving the most critical structures and canal reaches and in cases where water and suitable land is available. Support for major canal construction and/or rehabilitation is not practical and is limited to instances where seepage can be addressed, and where there is a large service area in terms of household coverage.

[28] Pipe size depends on availability of water discharge and typically falls in the 3"– 4" range.

Figure 5: Shallow Tube Well

5. HDPE Pipes

In hill areas where different sized reservoir tanks already exist, KISAN will provide this technology to farmer groups. Farmer groups will be supported with different sized HDPE pipes for delivery of water from tank to farmers' fields.

6. Small Lift System - Electric Motor (hill districts)

In areas where electricity is available, river or canal levels do not fluctuate excessively, and total lifts are less than 30-50 meters, pumping from rivers/canals is likely to be feasible. These schemes will only be developed where there is solid community support, since running costs are high, farmer cooperation is essential and conveyance losses must be kept to a minimum (e.g. canals should be fairly short).

7. Lift Irrigation (diesel pump)

In Terai districts where there is no possibility of installation of shallow tube wells, river levels do not fluctuate excessively, and total lifts are less than 30 feet, pumping from rivers via diesel pump is likely to be feasible. In addition to diesel pumps, KISAN will support (in conjunction with farmer group leverage) the suction pipe, foot valve and delivery pipes to the farmers' fields.

8. Drip Irrigation

In areas where there is no possibility of any of the above mentioned technologies, KISAN will provide a small drip irrigation set to the farmer group. This technology is suitable for space required by vegetables and high water scarce areas (*refer to Figure 6 below*).

Table 1. Details of Drip Irrigation System

SN	System	Number of Drip Pipe Lines	Number of holes	Coverage Area	Price (NPR)
1.	Very Small	4	80	2 Aana[29]	2,500
2.	Small	6	120	4 Aana	3,200
3.	Medium	8	160	½ Ropani[30]	4,200
4.	Large	12	240	1 Ropani	4,800
5.	Very Large	24	480	2 Ropani	8,000

Note: This is the average rate and final cost depends upon distance from supplier to retailer.

Figure 6: Drip Irrigation

[29] One aana = 342.225 square feet
[30] One ropani = 5,476 square feet

9. Sprinkler Irrigation

In hill areas where it is difficult to construct storage tanks on sloping terrain, where there is sufficient space (10-15 meter) available to rotate the metallic sprinkler, and where other technologies are not feasible, KISAN will support sprinkler systems with pipes for farmer groups. This type of technology is most suitable for closed spacing crops. Types of sprinklers include Butterfly Mini-Sprinklers, Arm Mini-Sprinklers, and Micro-Sprinklers (*refer to Figure 7 below).* Micro sprinklers typically have a 5-7 meter head; Arm Mini-Sprinklers have a 10 meter head; and Butterfly Mini-Sprinklers have a 10-15 meter head which corresponds to circulating power.

Figure 7: Different types of Sprinklers

ANNEX IV

Farmer Group Irrigation Scheme Request Template

(Date) the following persons of (Farmer Group name, location) participated in a group meeting and have taken the following decisions (KISAN staff - AMT/IT/DC also participated):

Name and Signature of all Farmer Group Members:

SN	Name	Position	Signature
1.			
2.			
3.			

Special Attendance:

SN	Name	Position	Signature
1.		DC/KISAN	
2.		IT/KISAN	
3.		AMT/KISAN	

Agenda of meeting:

1.
2.
3.

Conclusion:

1.
2.

Farmer Group Member Cultivation Details

SN	Farmer Group Member Name	Present Area of Cultivation (kattha)	Expanded Area after Intervention of Irrigation Facilities (kattha)	Remarks
1.				
2.				
3.				
4.				

Signature of all participating members (endorsing meeting minutes):

Name_____Signature_____

Name_____Signature_____

Name_____Signature_____

ANNEX V

Farmer Group Irrigation Scheme Agreement

Agreement between KISAN Project (representative name/title) and Farmer Group (representative name/title).

Name of Farmer Group:

District: _____VDC:_____ Ward no_____: Tol:_____

Name of Irrigation Scheme: _____

1. Nature of Agreement:

We, all members of (Name) Farmer Group, have agreed on the following criteria by USAID KISAN Project for implementation of the irrigation scheme (type of scheme) to increase our production area.

2 Responsibility of Farmer Group:

2.1 All necessary local materials such as mud, stone, sand, aggregate, and wood will be contributed by the Farmer Group.

2.2 Non-local materials/equipment such as motor, pipe, fittings will be procured jointly, by the Farmer Group and KISAN staff, from the nearby market and transportation will be contributed by the Farmer Group.

2.3 All of the unskilled labor required for completion of the scheme will be contributed by the Farmer Group.

2.4 All management of scheme preparation and installation will be led by the Farmer Group (e.g. hiring *mistrie*, in consultation with IT/AMT, unskilled labor etc.).

2.5 The KISAN Project will provide cash according to the agreed upon budget amount and the remaining amount (at least 33% of project total) will be contributed as match by the Farmer Group.

2.6 The KISAN Project will not provide material to the Farmer Group in lieu of cash but will assist with procurement as necessary in the presence of the Farmer Group (e.g. joint procurement).

2.7 The Farmer Group will provide land for installation of the irrigation scheme. Land for the scheme will be available for (detail period of time).

3. Additional assistance: In case of resources committed by other partners the Farmer Group should use the cash support for expansion of the scheme.

4. Responsibility of KISAN Project:

4.1 Budget required for the scheme (within fiscal ceiling) will be provided to the Farmer Group with IT assistance for the procurement of materials (not exceeding NRs. 40,000 exclusive of VAT).

4.2 KISAN will provide the technical support for implementation of schemes wherever necessary.

4.3 KISAN will provide the technical training to Farmer Group on repair and maintenance, conflict management and smooth operation.

5. Cost Details

SN	Material Type	From Farmer Group	Cash from Farmer Group	Leverage from line agencies	From KISAN project	Remarks
1.						
2.						
3.						
4.						

6. Cancellation of schemes: KISAN can cancel schemes if the above mentioned requirements are not fulfilled by the Farmer Group.

7. Repair and maintenance work: The Farmer Group is responsible for all maintenance and repair work for which the Farmer Group will raise funds on a regular basis.

Farmer Group Representative	KISAN Representative
Name:	Name:
Designation:	Designation: IT/AMT
Date:	Date:
Signature:	Signature:

ANNEX VI

Irrigation Scheme Completion Report

Today (date) the following people participated in the (Farmer Group Name) meeting, (of VDC name, district name) and made the following decisions:

SN	Name	Position	Signature
1.			
2.			
3.			

Special attendance:

1. Name: IT/KISAN
2. Name: AMT/KISAN

Meeting Agenda:

1. Completion of irrigation scheme (list type of scheme)
2. Public audit

Decisions:

1. As per agenda item #1 with the support of the USAID KISAN Project we have completed installation of (*type of irrigation scheme*) on (*date*) which was started on (*date*).
2. In regards to agenda item #2, the total cost details for installation of (*type of irrigation scheme*), of which we are in agreement, are listed below.

SN	Material	Quantity	Rate	Total Amount	Farmer Group Contribution	From KISAN Project	Remarks
1.							
2.							
3.							
4.							
5.							

We endorse the meeting minutes (*all farmer group members as well as KISAN staff signatures*):

Name_____Signature_____

Name_____Signature_____

Name_____Signature_____

Name_____Signature_____

ANNEX VII

KISAN Irrigation Training Guidelines

Table 1. Training Schedule

Time	Topic	Responsibility	Remarks
15 minutes	Introduction	All	
15 minutes	Training objectives	Irrigation Technician	
1 hour	Orientation on related technology	Irrigation Technician	
30 minutes	Technical orientation on operation of related technology	Irrigation Technician	
30 minutes	Importance of repair and maintenance	Irrigation Technician	
30 minutes	Lunch time		
1 hour	Practical orientation on basic repair and maintenance	Irrigation Technician	
30 minutes	Technical orientation on crop management	Agriculture Technician	
30 minutes	Technical orientation on water management and conflict management	Irrigation Technician	
15 minutes	Handover of tools and repair equipment	Irrigation Technician	
15 minutes	Closing	Irrigation Technician and all participants	

1. Training Objectives

- Orientation on the installed irrigation scheme
- Technical orientation on the operation of installed irrigation scheme
- Orientation on the importance of repair and maintenance
- Practical orientation on the basic repair and maintenance
- Handover of tools and repair equipment to the farmer group
- Technical orientation on crop management
- Technical orientation on water management and conflict management

2. Irrigation Background

Agriculture is the major occupation of about 80% of the Nepalese population. Irrigation plays a vital role in increasing agriculture productivity. Nepal is rich in water resources but still much of the agriculture production is based on rainfed irrigation. The most common irrigation schemes in Nepal include:

- Rainfed irrigation
- Surface irrigation
- Tube well irrigation

a). Rainfed Irrigation

Rainfed irrigation has been in practice from early times. Rain water is collected in ponds / reservoirs and later used for irrigation purposes.

b). Surface Irrigation

Although Nepal is rich in water resources surface irrigation is not much in practice. In this type of scheme, river flow is channeled through canals to agriculture plots. Different national level irrigation projects, such as Bagmati Irrigation Project, Sunsari Irrigation Project, Morang Irrigation Project and other irrigation projects run by the irrigation divisions and District Irrigation Offices, fall in this category.

c). Tube Well Irrigation

Irrigation schemes vary depending upon geographical location. Tube wells are commonly installed in the Terai to source ground water where surface irrigation is not possible. There are different technologies to extract the ground water for irrigation purposes, such as shallow tube wells and deep tube wells, depending upon the land/soil structure.

3. Necessity of Irrigation

- Unpredictable rain / seasonal monsoon
- Unequal distribution of rainfall
- High productivity crops that require extensive watering
- Variable water storage capacity of the soil

4. Irrigation Technologies Promoted by the KISAN Project

- MUS
- Water collection tanks
- Canal repair
- Shallow tube well
- HDPE pipe
- Lift irrigation (electric motor)
- Lift irrigation (diesel pump)
- Drip irrigation
- Sprinkler irrigation

5. Irrigation Management and Conflict Management

The KISAN Project supports irrigation schemes for prioritized farmer groups, not for individual farmers, and special attention is paid to the planning phase. If a group is unable to manage the irrigation scheme properly, there is the possibility of conflict arising between its members. Thus, proper management of the irrigation scheme for use and conflict mitigation/management should be carried out side by side. Special consideration of the points listed below, from selection of irrigation scheme to installation and interval of use will help to manage the irrigation scheme properly and lessen the possibility of conflict between group members.

- *Selection of feasible irrigation scheme:* The scheme should be accessible to a decent number of the farmer group households. Before installment, there should be consent from all of the group members in regards to irrigation site selection.
- *Priority of use:* As all the beneficiaries cannot use the irrigation facility at the same time, the group should prioritize who will use the irrigation facility first, along with subsequent rotation order, to effectively manage the scheme.
- *Repair and maintenance:* Based on the group decision, the beneficiaries of the scheme should contribute some money on a regular (e.g. monthly) basis for the support of a repair and maintenance fund which can be used whenever required.
- *Diesel engine use:* If a diesel engine is used, any member of the group benefitting from the installed scheme should be responsible for taking care of the engine. All the members should contact the responsible focal person to use the engine. Once the members use the engine, they should refill with diesel and return to the responsible person.
- *Electric motor use:* If an electric motor is used, the member who uses the engine should record the electricity meter unit at starting time and pay the fee for electricity use while operating the engine.
- *Non-farmer group member use:* If non-members want to use the irrigation facility, it could be allowed based on the group decision and the fee charged to the user should be deposited in the Operation and Maintenance fund.
- *Income and expenditure details:* Financial updates should be reported during monthly meetings.
- *Post-irrigation scheme installation:* it is expected that the beneficiary farmers should increase their agriculture cultivation area. For effective management purposes, a member of the beneficiary group can be nominated responsible for the scheme operation for which s/he should be compensated for services provided.

6. Irrigation Technical Features

a). Introduction - Shallow Tube Well

Shallow tube wells are constructed with the installation of three to four-inch diameter pipe at relatively shallow depths to extract the water stored in the shallow aquifer water reservoir. The Ground Water Resources Development Project defines a shallow tube well as having up to a fifty-meter depth with four-inch diameter pipe. In excess of fifty-meters depth is regarded as a deep tube well.

In shallow tube wells, rain water is stored in the ground water reservoir passing through gravel and sand. Before construction of a shallow tube well, it is important to get the detailed information about wells in the surrounding area, hand pump water level etc., because a hand operated pump set cannot extract water below the depth of seven and a half meters. It is not recommended to construct shallow tube wells with four-inch diameter pipe where the water level is deeper than seven and one half meters unless a motor is used for extraction.

b). Types of Filters

1. A socket is placed on both sides of a half-inch iron ring between the nipple and welded iron rods. Nylon cloth or coconut fiber is used to bind it and make the filter.

2. Slotted filter: This is the most popular type of filter which is placed in all types of soil layers and it is not affected by gravel packing. This filter is also made of iron or PVC pipe. This is not used in the hammering method of tube well construction. The filter is made of holes in the pipe and can be only up to three meters long.

3. Perforated Filter: This filter is only used in the hammering method. It requires B or C grade pipe (*refer to description of pipe categories below).* The 10 millimeter holes are made in the filter. This kind of filter is not used in sand aquifers as this extracts only sand through tube well pumping.

c). Pipe Information

The materials required for the installation of shallow tube well includes mostly pipes and filters. Based on the thickness and thread of the wall of iron pipes, the pipes are categorized into 3 grades:

1. “C” grade (Heavy)

2. “B” grade (Medium)

3. “A” grade (Light)

“C” grade is the best one made of high quality material. These pipes are used in large scale industries and also in shallow tube wells constructed with the hammering method. Shallow tube wells constructed using other methods do not use “C” grade pipe because it is comparatively more expensive than other grade pipes.

“B” grade pipes are widely used in most of the tube well installations. Slotted filters are made from “B” grade pipes.

“A” grade pipe is not used with the hammering method of tube well installation because it is light, made of soft material and the wall is thin. Mild steel (MS) pipe and galvanized steel (GS) pipe are also of this grade. Plastic pipe is made of soft density material while iron pipes are made of hard density material. Polythene pipe and UPVC (unplasticized polyvinyl chloride) polythene pipe are high density plastic pipes.

High density polythene pipe: This pipe can be used for installation of shallow tube wells. This pipe is cheap but difficult to use because it is bendable. However, these pipes are used mostly for creating holes in the pipe for perforated filters. Also, slotted pipes are made of the high density polythene pipe.

UPVC polythene pipe: This pipe is best for the installation of shallow tube wells and is long lasting inside the tube well. Different filters are made of this pipe.

d). Shallow Tube Well Construction Procedures

1. By man:

- Pressure method
- Hand rotary
- Hammering method

2. By machine:

- Direct circulation rotary
- Reverse Circulation rotary
- Cable tool or percussion

Multiple Well Systems

Where there is limited availability of underground water, a multiple well tube well system can be applied. The technique of installing two or more than two shallow tube wells in the same location with a common pump outlet is called T-system or Multiple Well System. In this system, two or more tube wells are joined with the T- system. If two tube wells are used then they can be kept face to face. If four are used then they can be kept in four different corners. Similarly, if three tube wells are utilized they can be positioned in a triangle shape.

e). Back Washing

There may be a problem with clogged sand present in the compacted filter bed in places where minute sand is found. In this situation backwashing is done to clear the sand by using a casing around the main source which is covered by gravel packing to prevent clogging.

f). Diesel Engine

In 1892 A.D., a German engineer, Rudolf Diesel invented diesel. The **diesel engine** (also known as a **compression-ignition** or CI engine) is an internal combustion engine in which ignition of the fuel that has been injected into the combustion chamber is initiated by the high temperature which a gas achieves when greatly compressed. (Wikipedia).

g). Engine Types/Specifications

Model	160F	160F	170F	R166	R170	R175
Engine power	2 HP	2.5 HP	4 HP	3 HP	4 HP	5 HP
Engine R.P.M	2,600	2,600	2,600	2,600	2,600	2,600
Fuel consumption per HP	238 gm/hr	229 gm/hr	213 gm/hr	238 gm/hr	225 gm/hr	220 gm/hr
Oil consumption per hour	5 gm	8 gm	13 gm	10 gm	13 gm	19 gm
Bore stroke	60X60	63X65	70X70	65X60	70X60	75X72
Engine type	Four stroke horizontal single cylinder					
Engine cooling system	Wind blower			Water		
Engine starting system	Handle					
Fuel capacity in liter	2.8	2.8	4.5	2.8	3.5	3.5
Pump size	1.5X1.5	2.0X2.0	3.0X3.0	2.5X2.5	3.0X3.0	4.0X4.0
Discharge capacity (lit/hr)	125	20,000	38,000	280,000	380,000	650,000
Suction height (meter)	32	20	15	15	15	10
Suction head (meter)	7.5	7.5	7.5	7.5	7.5	7.5
Engine weight (kg)	23	24	44	28	30	48
Engine weight with pump (kg)	43	45	65	55	68	75

Note:

1. Power rate and fuel consumption depend on the following:
   - Environmental pressure: 750 mmHG[31]
   - Temperature: 25^{O}Celsius
   - Relative Humidity: 30%
2. Engine's lower caloric valve should not be less than 10,200 K.C. per kg.

h). Operation

The following guidelines need to be followed for proper engine operation. However, if the engine is not used for a long period of time then additional care and maintenance should be followed.

- *Preparation for operation:*

  Before operation of the engine, bolts should be checked and tightened. Good quality and quantity of lubrication oil should be used. In winter and summer seasons, it is advisable to use H.C. 8 and H.C. 11 lubricating oil respectively. The fuel tank should be kept clean. After opening cylinder head cover, one drop of oil should be put on the valve rocker arms and valve guide and the cover should be closed. The fuel cork should be twisted to open. If air is present in the fuel pipeline, the injection pump should be opened to release air, and later on the screw should be closed.

- *Procedure to start engine:*

  The decompression lever should be lifted up by the left hand. The speed control handle should be kept on high speed. The right hand should then be used to turn the handle. While doing so, a chattering sound is produced which indicates that fuel is being injected into the combustion chamber.

[31] This is the symbol representing a millimeter of mercury.

The machine should be slowly moved by the handle and decompression lever should be freed. However, the engine should be stimulated once or twice so as to start. When the engine is started the handle is automatically disconnected so the operator should be careful at this time.

When the engine starts, it produces unnecessary smoke. To control this smoke, the accelerator handle should be placed down and for time being no load should be put on the engine.

In case of difficulty starting an engine when it is cold, it is best to use intake pipe oil.

- *Technique to stop engine:*

In order to stop the engine, the speed should be controlled by pushing the handle. Leave at that stage for a little while and the engine will stop. The fuel lever should be turned to the closed condition. If the engine was not operated for a long time then the fuel and lubricating oil should be replaced. If the engine will be left unused for a long time then the valve should be closed in order to prevent the cylinder from rusting. As the valve is inside engine it is hard to see. The fly wheel should be rotated completely until it resembles an 'O' shape. It should be rotated until it reaches the air cooling's timing mark at which point the valve will be closed.

- *Precautions while operating engine:*

a. For up to three minutes after the engine is started, the machine should be operated at a slow speed without any external pressure. After a little while, pressure can be applied.
b. After continuous operation of the engine for eight hours, the lubricating oil should be checked. If the level of the oil is below the indicator line then good quality oil should be added.
c. During operation of the engine, attention should be paid to the color of smoke and sound of the engine. If the engine is producing black smoke and a different sound, then it should be stopped immediately. If no black smoke is produced then it is a sign that the engine is in good condition.
d. The engine should be kept in a cool and open place so that it continues to function properly. The fan can also be used to cool the engine.

- *Sudden stoppage:*

If the engine speed becomes abnormal and a different sound is produced during regular operation then it is hard to stop normally. The condition is called ‘running condition’ and to stop the engine in this condition the following steps should be taken:

a. The knot joining injection pipe should be opened immediately.
b. Fuel pipe should be pulled out.
c. The easiest way is by pulling the decompression lever upward.

i). Troubleshooting Engine Operational Difficulties

If the engine does not start	
Cause/s	**Solution**
If environment is too cold	Put lubricating oil in intake pipe
Problems in engine • Mixing of water in fuel • Fuel flow is very low • Mixing of air in fuel • Clogged fuel line	 • Clean fuel tank, fuel filter, fuel delivery pipes (both in-flow and out-flow) and fill the tank with clean/pure fuel. • Use specific standard of fuel or use warm fuel • Get rid of air • Check and fix nozzle and fuel injection pump
Problems in valve clearance	Check and fix valves
Poor quality of lubricating oil	Drain the existing lubricating oil and use high quality lubricating oil
Low compression:	
• Leakage from cylinder head due to problems in gasket and if nut is not tight • Wear and tear of ring gap and over-sized ring gap due to wear and tear • Tiltation of all ring gaps in one direction • Malfunction / dysfunction of piston ring • Leakage from valves • Blockage in valve pipe	• All nuts should be tightened properly and use gasket as required • Replace piston ring • Proper adjustment of ring gap • Clean piston ring with lubricating oil/ replace • Check and adjust valves. Use kerosene to identify the reason/s of leakage • Check and clean valve pipe
If the engine does not work properly	
Cause/s	**Solution**

Problems due to fuel
• Fuel does not flow in engine
• Injection pump is not working
• Injector is not working
  • Opening pressure is wrong
  • Carbon deposits in nozzle
  • Needle valve is not working
  • Frequent problems in needle valve and nozzle
	
	• Use clean fuel and ensure fuel tank is covered
	• Check and ensure that pipe lines are clear
	• Check, repair or replace pump
	• Clean the gear
	• Clean nozzle
	• Fix or replace needle
	• Replace

Low compression speed:	
Low engine speed	Adjust speed through speed adjustable spring and increase speed
Blockage of air filter	Clean or replace
Fuel flow process is not working	Re-adjust
Water cooling pipe not properly connected	Check, clean and re-connect
If engine stops	
Cause/s	**Solution**
Problems due to fuel • Empty fuel tank • Blockage of fuel pipe line or filter	 • Add fuel in tank • Check and clean

• Mixing of air in fuel • Blockage of needle valve	• Extract air from fuel • Check and clean/replace as required
If injector makes little or no sound during engine starting:	
If air cleaner is not working or blockage in air filter	Clean or replace
Piston does not work due to overheating of engine Smoke exhaust appears immediately after engine starts	Stop engine, open and fix the piston Immediately turn off and restart. If piston is damaged requires maintenance.
Sudden increase of load in engine	Lower the load
Connecting rod stopped due to blockage of pores in oil sprinkler	Open and check. Clean/clear oil sprinkler and oil passage. Replace connecting rod wearing if required.

If engine emits black, blue or white smoke[32]	
Reason and symptom	**Solution**
Black smoke emission is due to incomplete fuel burn • Overload in engine • Fuel injector is not working properly and fuel efficiency is low • Big clearance between piston and liner	 • Load reduction • Proper adjustment of nozzle, injector and if required, repair or change. • Clean and repair
Blue smoke emission is due to burning of lubricating oil in cylinder • Overuse of lubricating oil • Wear and tear of piston ring • Big clearance between piston and liner	 • Remove excess oil or change as required • Change or clean/repair piston ring • Adjust and repair piston and liner or change as required.
White smoke emission means the mixture of air or water in fuel and fuel flow is low. • Presence of water in fuel • Blockage of needle valve	 • Use filtered and clean oil. • Clean or change needle valve

j). Engine Safety:

To maintain the engine for the long term, the following steps should be followed:

- ✓ Remove all the fuel and lubricating oil from engine.
- ✓ Clean and wipe the engine surface.
- ✓ Put the boiled oil inside intake pipe and shake the engine so that it touches piston, cylinder and valve set. Keep in condition where all the valves will be closed.
- ✓ Remove the head cover of the engine, rocker arm and other parts and clean with the boiled lubricating oil.

[32] Emission of brown smoke means that the engine is in good condition.

- ✓ Air filter, exhaust pipe and fuel tank should be covered properly to make sure there will be no exposure to dust.
- ✓ Keep engine in room where there is no dust, good air circulation and less humidity.

ANNEX VIII

Irrigation Case Studies

1). KISAN collaborates with other USAID funded projects

KISAN is working with other USAID funded projects where possible, to support the beneficiaries in common working VDCs. One such example is the collaboration of KISAN and Sajhedari Bikas to install ten shallow tube wells in Kamdi VDC of Banke District. The MOU was signed on May 28, 2015 with agreement that Sajhedari Bikas and community will bear the installation cost and KISAN will provide the technical trainings. Of the total installation cost (Rs. 484,557), Sajhedari Bikas contributed Rs. 475,000 and the community contributed Rs. 9,557. Likewise, KISAN trained the farmers on operation, repair and maintenance of the shallow tube wells. The trainings include engine fitting, knot bolt tightening, information on diesel and lubricant type, feeding in machine, minor repair and maintenance, pipe used, filters and overall operation of the machine. The shallow tube well irrigation project Users Committee with 11 members belonging to the *Madhesi* ethnic group, was formed under the chairmanship of Mr. Suresh Kuwar. This committee was active during site selection for tube well, management and maintenance decisions and mobilization of funds for the tube well implementation activities.

This scheme benefits 55 households from three farmer groups namely, Shiva Mandir Krishak Samuha, Sairi

Fig 1: The shallow tube wells are expected to irrigate about 40 hectares of agriculture land for the production of rice, maize and vegetables.

Fig 2: Before installation of these irrigation schemes, farmers relied on rain fed agriculture production. Very few farmers could afford to rent pump sets at the rate Rs. 150 to Rs. 200 per hour to irrigate their land.

Mata Krishak Samuha and Nijamuddin Krishak Samuha. Nine shallow tube wells have already constructed while the remaining one will be installed after the rainy season is over.

The farmers were growing cereal crops and vegetables using traditional methods and the seed replacement rate was also very low. Only about 15 households sold vegetables for which they had to travel to the market place in Ranitalau on their own, while others grew vegetables only for household consumption. Prior to installation of the irrigation system, these farmer groups received agriculture training from KISAN covering a variety of cropping cycle topics including nursery management, post-harvest handling, marketing and improved agriculture technologies, which further continued with

irrigation trainings and demonstration of improved technologies for rice, maize and vegetables spread on about 0.4 hectare after installation of the shallow tube wells. A demonstration plot for growing bottle gourd, bitter gourd, and long-bean using staking was spread over about 0.24 hectare. Other demonstration plots were also carried out including for rice planting using the US-312 variety in the line sowing method on about 0.05 hectare; and the "Kanchan 101" improved variety of maize using a jab planter on about 0.12 hectare.

Fig 3: Farmers from these groups found that staking maintained equal space, led to early harvest with large and cleaner vegetables with less rot and more vegetables per plant. There was no water logging problem and helps grow plants faster and healthier.

With access to the irrigation facility, knowledge on improved technologies and linkages with different agrovets such as Munal, Model and Vishal Agrovet for seed, fertilizer and other inputs facilitated by KISAN, about 40 households started commercial vegetable production. They grew long beans, bitter gourd and bottle gourd using staking and also managed tomato and cauliflower nurseries. This season, the farmers tried plantation using improved agriculture technologies they have learned along with planting crops using traditional methods. Daya Ram, one of the Sairi Mata Farmer Group members, grew about 1,950 kg. of bottle gourd and bitter gourd on about 0.1 hectare from which he earned approximately Rs. 30,750 from the first harvest. Similarly, Satguru, another member of the same group, sold about 1,800 kilograms of bottle gourd, bitter gourd and long beans grown over about 0.14 hectare, from which he profited Rs. 36,500. The harvest of the vegetables is still going on. The farmers do not have to the travel market place to sell their produce as a trader comes to collect the vegetables. This has further encouraged them to increase area of production for increased revenue generation.

Fig 4: Growing bitter gourd in the traditional way

Fig 5: Growing bitter gourd using stakes

Daya Ram planted rice using both the traditional method as well as improved technology of transplanting seedlings utilizing the line sowing method in straight rows following uniform spacing between plants. He found that planting rice using line sowing helped to maintain proper spacing between crops with less weeds. With proper spacing, it also saved money on agriculture inputs such as seed, fertilizer and labor. In addition, this approach minimizes shading and as a result the crop grows better. Because of these

benefits, Daya Ram plans to grow rice on all of his land using the line sowing method starting with the next planting season.

Fig 6 Daya Ram's rice demo plot with line sowing method at the side of road. Other farmers passing by the road have also observed and learned this technique.

The farmers also planted the "Kanchan 101" maize variety on about 0.12 hectare using a jab planter. The seed and fertilizer is placed in the jab planter for plantation. The farmers found that this technique saves seed, fertilizer, time, labor cost. It also maintains proper spacing between plants which increases the production, and minimizing shading.

With this transformation in cropping practice, using the improved seed variety, agriculture techniques and irrigation facility, the farmers expect to increase their production by 50%. Expected production increase with the improved rice variety ranges from 3–4 metric tons to 4-6 metric tons per hectare; with the hybrid rice from 5-6 metric tons to 8-10 metric tons per hectare; with the improved maize from 2.5 – 3 metric tons per hectare; with the hybrid maize from 5-6 metric tons to 10 -12 metric tons per hectare; and with average vegetable production from 10 metric tons to 20 metric tons per hectare.

These farmers further plan to register their group with DADO and the Division Irrigation Department and plan to put together a proposal for an electricity line after learning about the available subsidy for commercial agriculture.

According to Sataguru, '*Many projects were in this village to collect information with the farmers and with commitment to support our community but they never come back. But the KISAN project has been continuously in touch with us, providing trainings, technical support and helping to build linkages with different agriculture input suppliers and now, the ten irrigation schemes. We are committed to follow the path shown by KISAN and continue and expand this commercial agriculture business even after the KISAN project ends."*

Fig 7: Sataguru feels that the jab planter is simple to use for maize production. The community has not charged a fee for using the jab planter but they are planning to charge a minimum amount from Rs 20 to Rs. 25 so that they can use the same fund for its maintenance.

2). Peace Corps and KISAN Team up to Improve Agriculture Productivity and Market Access in Pyuthan

Fig 1: Water is lifted 300 meters from the Madi River to this reinforced concrete tank as part of an irrigation scheme designed by Peace Corps Volunteer Owen Duncan.

The USAID KISAN Project is providing technical and cost-share support for community irrigation systems in 20 Feed the Future districts in the West, Midwest, and Farwest regions. Irrigation, together with the application of new technologies, such as improved seed varieties, proper soil fertilization, and the use of IPM technologies can double production and income for farmers. KISAN and Peace Corps volunteer Owen Duncan have teamed up to bring new agricultural technologies to a small community in Belbas VDC in Pyuthan District. Duncan, an agricultural engineer by training, is working closely with the community to develop a lift irrigation scheme that will irrigate four hectares and benefit 27 families. To date USAID's KISAN Project has provided technical advice, cost-share support, and training for the implementation of 337 small scale irrigation systems, covering approximately 1,000 hectares and benefiting more than 6,300 Nepali households.[33] To help farmers take full advantage of their new irrigation systems, KISAN and KISAN's intermediaries and partners, including agrovets, traders – and like Peace Corps Volunteer Duncan Owen – provide training and advice to farmers on new technologies and on the new market opportunities that year round water creates.

[33] These figures were up to date at the time of case study submission to USAID on September 7, 2015.

3). **Seed Production Farmer Group in Dang: Climate Smart Varieties Compete with Hybrids in Satbariya**

KISAN is working with 36 farmer groups (764 farmers) in Satbariya which is a very good potential production area in Dang District. Badka Krisak Samuha is one of the farmer groups in Satbariya that has been involved in rice seed production since 2013. The group members grow rice, maize and vegetables for their own consumption. Prior to KISAN support, they had a deep tube well in place supported by the Karri Community Forest but it was not in functioning condition.

KISAN formed Badka Krisak Samuha in 2013 and subsequently provided a variety of trainings focused on vegetable production, as well as established a demonstration site, and assisted the group to become registered with DADO. After registration they got the opportunity to make a functional deep tube well and KISAN supported the group to construct an irrigation channel which motivated the farmers to do something as agriculture entrepreneurs. In 2014 KISAN encouraged the group to embark on rice seed production, especially the climate smart variety ("Sukkha 3"), and arranged a linkage with the Bij Bridhi Seed Company from Chitwan. In addition, KISAN prepared a MOU between the company and the farmer group for market assurance.

Fig 1: Mr. Annata Ram Chaudhary of Badka Farmer Group roughing out the off-breed in Sukkha-3 at Satbariya-2, Banghsari.

The seed growers are happy after harvesting and selling their product (Rs. 25 for rice seed as opposed to Rs. 17 for grains) which is encouraging them to continue next year by expanding the seed production area and diversifying into winter maize seed beginning this season. The group not only believe in production but are also utilizing mechanized equipment as represented by the fact that eight farmers out of the nineteen group members have access to power tillers. The group members also have a routine savings practice, putting aside Rs. 50/household every month. They have collected about Rs. 80,000 which is circulated as a credit to group member as needed.

In Banghuari of Satbariya VDC, 90% of the farmers have replaced hybrids with the Sukkha series due to drought tolerance, good taste and solid production, as well as availability in the community. Badka Krisak Samuha supplies the produced seed not only to the Chitwan based seed company but also to local agrovets and agriculture cooperatives. The farmer group's future plan is to expand their seed production area with diversified seed crops.